

For Reference

NOT TO BE TAKEN FROM THIS ROOM

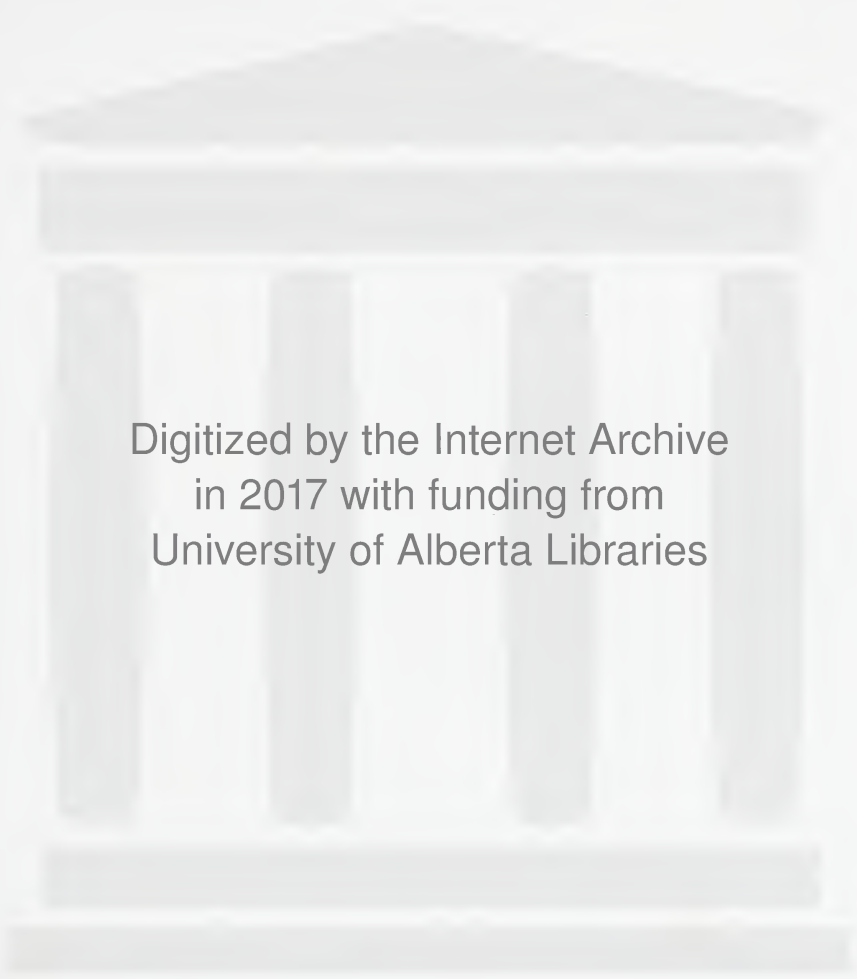
Library of the University of Alberta, Edmonton, Alberta

Doney, Orval J.

The construction of an arithmetic
survey test for use in the Edmonton
schools

Ex LIBRIS
UNIVERSITATIS
ALBERTAENSIS





Digitized by the Internet Archive
in 2017 with funding from
University of Alberta Libraries

<https://archive.org/details/constructionofar00orva>



THE UNIVERSITY OF ALBERTA

THE CONSTRUCTION OF AN ARITHMETIC SURVEY TEST
FOR USE IN THE EDMONTON PUBLIC SCHOOLS

A DISSERTATION
SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF EDUCATION

FACULTY OF EDUCATION

BY
ORVAL J. DONEY
EDMONTON, ALBERTA
JULY, 1952.

ACKNOWLEDGEMENTS

The writer wishes to express his grateful appreciation to Dr. George M. Dunlop who suggested the procedure to be used in the preparation of the test and who directed the writing of this thesis. The helpful advice and critical observations pertinent to its development are gratefully acknowledged. The writer also expresses his gratitude to Mr. A. G. Bayly for his assistance in the distribution, supervision and evaluation of the test, to Mr. W.P. Wagner for guidance in organizing the samples, to Mr. R. E. Patterson, Mr. A. V. Cameron, and the late Mr. R.M. Cupples for their cooperative efforts during the preparation of the test, to Mrs. I. G. Dunlap for her careful reading of the manuscript, and to the many staff members of the Edmonton Public Schools who so painstakingly and faithfully supervised the writing of the test and collected the data that made possible the grade norms and percentile ratings.

TABLE OF CONTENTS

CHAPTER	PAGE
I. THE PROBLEM	1
II. PREVIOUS SURVEY TESTS	5
III. PLANNING THE TEST	9
IV. TEST RESULTS OF THE FIRST ADMINISTRATION	12
V. EVALUATION OF THE TEST	17
VI. PLANNING THE REVISION OF FORM A	26
VII. FINAL ADMINISTRATION OF THE TEST	40
VIII. EVALUATION OF THE DATA RESULTING FROM THE FINAL ADMINISTRATION OF THE TEST	45
IX. NORMS	51
1. Grade Score Norms	51
2. Grade Percentile Norms	57
X. THE RELIABILITY AND VALIDITY OF FORM A, REVISED	60
XI. CONCLUSIONS AND RECOMMENDATIONS	65
I. Conclusions Concerning Forms A and B	65
II. Recommendations for Committees Attempting Construction of Tests in Other Areas	65
BIBLIOGRAPHIC REFERENCES	67
APPENDICES	69
I. Manual of Directions for the Edmonton Arithmetic Survey Test Form A, Revised Grades 4, 5 6, 7, 8.....	70
II. Edmonton Arithmetic Survey Test Form A, Revised	80

LIST OF TABLES

TABLE	PAGE
1. Grade Attainment in Vocabulary and Fundamentals, Computation, and Problem Solving on the First Administration of the Test to the Random Sample of Five Hundred Pupils	13
11. Grade Attainment in Vocabulary and Fundamentals, Computation, and Problem Solving on the First Administration of the Test to the Random Sample of Five Hundred Pupils	14
111. Grade Attainment in Vocabulary and Fundamentals, Computation, and Problem Solving on the First Administration of the Test to the Random Sample of Five Hundred Pupils	15
IV. Grade Attainment by Composite Scores on the First Administration of the Test to the Random Sample of Five Hundred Pupils	16
V. Median Scores and Median Score Differences of the Vocabulary and Fundamentals, Computation and Problem Tests of Form A on the First Administration to the Random Sample of Five Hundred Pupils	18
VI. The Medians of the Composite Scores and the Differences of the Composite Score Medians on the First Administration of Form A to the Random Sample of Five Hundred Pupils	22
VII. Grade Attainments in Items Deleted from Form A, Vocabulary and Fundamentals	28
VIII. Grade Attainment in Items Selected from the Supplementary Test in Vocabulary and Fundamentals.....	29
IX. Grade Attainment in Items Deleted from Form A, Computation	30
X. Grade Attainment in Items Selected from the Supplementary Test in Computation	31
XI. Grade Attainment in Items Deleted from Form A, Problems	32
XII. Grade Attainment in Items Selected from the Supplementary Test in Problems	33

LIST OF TABLES (Continued)

TABLE	PAGE
XIII. Predicted Median Scores and Median Score Differences of the Vocabulary and Fundamentals, Computation and Problem Tests of Form A, Revised	35
XIV. Predicted Medians of the Composite Scores and the Differences of the Predicted Composite Score Medians of Form A, Revised	38
XV. Grade Attainment in Vocabulary and Fundamentals, Computation and Problem Solving of Form A, Revised	41
XVI. Grade Attainment in Vocabulary and Fundamentals, Computation and Problem Solving of Form A, Revised	42
XVII. Grade Attainment in Vocabulary and Fundamentals, Computation and Problem Solving of Form A, Revised	43
XVIII. Grade Attainment by Composite Scores of Form A, Revised ..	44
XIX. Median Scores and Median Score Differences of the Vocabulary and Fundamentals, Computation and Problem Tests of Form A, Revised	45
XX. Medians and Median Differences of the Composite Scores of Form A, Revised.....	48
XXI. Raw Scores with Grade Score Equivalents on the Vocabulary and Fundamentals, Computation, and Problems Sub-tests of the Edmonton Arithmetic Survey Test Form A, Revised, obtained on a Random Sample of Five Hundred Pupils	55
XXII. Grade Score Equivalents for Composite Scores on The Edmonton Arithmetic Survey Test Form A, Revised, Based on a Random Sample of Five Hundred Pupils	56
XXIII. Table for Assigning Letter Ratings to Pupils on the Basis of the Percentile Rank of their Scores on a Test	58
XXIV. Grade Percentile Norms of the Composite Scores of Form A, Revised, Obtained from a Random Sample of One Hundred Pupils Per Grade and Given at the End of the Fourth Month ...	59

LIST OF FIGURES

Figure	Page
1. Median Scores of the Edmonton Arithmetic Survey Test, Form A, on the First Administration to the Random Sample of Five Hundred Pupils	20
2. Median Scores of the Edmonton Arithmetic Survey Test, Form A and Form B, on the First Administration to the Random Sample of Five Hundred Pupils, Composite Score Data	24
3. Predicted Median Scores of the Edmonton Arithmetic Survey Test, Form A, Revised	37
4. Predicted Median Scores of the Edmonton Arithmetic Survey Test, Form A, Revised, Composite Score Data	39
5. Median Scores of the Edmonton Arithmetic Survey Test, Form A, Revised	47
6. Median Scores of the Edmonton Arithmetic Survey Test, Form A, Revised, Composite Score Data	50
7. "Best-Fitting" Line for the Median Scores of the Edmonton Arithmetic Survey Test, Form A, Revised	53
8. "Best-Fitting" Line for the Medians of the Composite Scores of the Edmonton Arithmetic Survey Test, Form A, Revised ...	54

CHAPTER 1

THE PROBLEM

Mathematics is basic to modern society. The working citizen must be quick and accurate in computation. It is desirable for him to understand problems, to analyze accurately, and to reason deductively and inductively in the field of mathematics. The cultured citizen requires a knowledge of mathematics to make him more fully aware of the contribution of mathematics to the development of modern society. The democratic citizen needs as extensive an appreciation as he can get of the work of his fellow citizens, not the least of whom are the mathematicians, the scientists, the engineers, and the accountants. Ideally every pupil is potentially a working, cultured, democratic citizen.

All aids to the successful teaching of arithmetic are therefore important. How often is a child's slow progress in arithmetic based on lack of mathematical ability, and how often on specific weaknesses caused by failure to master particular topics in his earlier work? Any expedient which will assist a teacher in an attempt to determine the reason for a child's inability to master his work is worthy of attention. A carefully prepared arithmetic survey test is one device which may be used to advantage in such an undertaking. Its worth is indicated in several ways.

To begin with the general score obtained by pupils from a survey test gives the teacher some indication of each child's strength or weakness in arithmetic. This knowledge is of particular value at the beginning of a term. At that time the class can be divided into two or more groups

according to their ability and development, and instruction adjusted to the specific needs of each group. By making this arrangement flexible each child can advance to the better group as soon as he reaches the required level of proficiency.

A survey test is not properly a diagnostic test. However, if it is organized into suitable sub-divisions, the component scores that make up the total survey score have value for diagnosis and remedial work. They may indicate broad areas of weakness though it is not their function to locate specific difficulties. For that purpose a teacher should administer a diagnostic test to determine the specific weakness and then outline remedial work to overcome it. When this work is satisfactorily completed another form of the survey test should be administered as a measure of the effectiveness of the program.

An equally important function of the survey test is to determine the need of preventive work. If it reveals a persistent general weakness in an arithmetical process improvement should result if attention is directed to the grade or the area where the process is first taught. Where the difficulty appears in just one school it may be the result of careless teaching. Stress laid upon the initial teaching of the topic in question may lessen or even eliminate further failures in it. Should the same weakness be found in several schools other causes must be sought. Is the topic being taught too early in the grade system? Is it one whose difficulties which, though not apparent to the adult mind, still require recognition by the teacher? Or is it one whose inherent difficulty will prove a challenge to the alert teacher and research worker? In any event the survey test serves to concentrate the attention of the administrator

on processes needing investigation.

A properly constructed survey test exhibits several essential features. From the standpoint of validity the test "must parallel the teaching of the subject"¹ and must be based upon the textbook or the textbooks used. It should separate the poor students from the good ones. Although the test should be adequate in its sampling of the subject it must include only the more important aspects of that subject. Skilled and experienced teachers should select the test items from those topics which not only "fit the main objectives of the course"² but which have the "biggest residual social value"³. The test questions should be written in "clear, simple English"⁴ and be arranged in ascending order of difficulty so as to secure maximum pupil interest and effort. Finally an arithmetic test is of little value without well authenticated norms appropriate to the local situation.

There are already a number of tests available for survey purposes. Why, then, prepare another? Most of these tests possess certain weaknesses which make them more or less unsuitable for evaluating progress in arithmetic in the Edmonton Public School system. One outstanding weakness is common. The norms of achievement which accompany the tests have not been established on the data secured from our local school population. Most tests have no sub-section designed for testing the pupil achievement in vocabulary and fundamental knowledge. Others focus attention solely upon computation. Many fail to give any data on the reliability and validity of the test. In a few of them inaccurate and misleading statements occur.

Because of the known defects in presently available tests it was thought advisable to prepare another survey test. It was hoped that this test, on the whole, might be prepared in a form which would be more suitable for use in the Edmonton schools than any of the current ones. Since it would be prepared by Edmonton teachers the questions selected would be based either upon the textbooks in current use here or upon the main topics as outlined in our course of studies. Norms obtained after the administration of the test to our local pupil population would be more accurate for rating pupil progress locally.

The purpose of this study, then, has been to plan and prepare an arithmetic survey test for use in the Edmonton Public Schools from grade four through eight. This test is designed to contain the essential features, cited above, of an ideal survey test. At the same time it is a serious attempt to evaluate the understanding on the part of pupils of elements of arithmetical knowledge⁵ since these elements are progressively being more widely accepted as legitimate outcome^s of instruction.

CHAPTER 11

PREVIOUS SURVEY TESTS

There are eleven reputable survey tests in arithmetic widely used on the continent today. They are listed below. An evaluation could be made of each of these with respect to the several essential features that were mentioned in the previous chapter. Comment here, however, will be restricted mainly to the special defects or limitations found in each.

Analytical Scales of Attainment in Arithmetic.

Grades III to VIII. Minneapolis: Educational Test Bureau.

Contains tests of processes, problems, arithmetic vocabulary, and quantitative relationships.

Brueckner, L.J. Coordinated Scales of Attainment in Arithmetic.

Grades I to VIII. Grades I and II, elements of mathematical and social phases of arithmetic. Grades III, IV, V, VI, VII and VIII, computational skills and reasoning in problem solving. Minneapolis: Educational Test Bureau.

Brueckner, L.J. Progress Tests in Arithmetic Processes.

Philadelphia: John C. Winston. A series of 10 monthly tests in processes for each of Grades III to VIII.

Brueckner, L.J. Progress Tests in Problem Solving. Philadelphia:

John C. Winston. A series of 10 monthly tests in problem solving for each of Grades III to VIII.

Compass Survey Tests in Arithmetic. Iowa City: State University of Iowa. Grades II to VIII. Tests of processes and problems.

Dominion Tests in Fundamental Operations. Toronto, Ontario.

Department of Educational Research, Ontario College of Education, Vocational Guidance Centre. Grades IV to VIII.

Iowa Every-Pupil Test in Basic Arithmetic Skills. Iowa City:

State University of Iowa. A comprehensive testing program for Grades VI, VII, VIII, including vocabulary, problems, processes and arithmetic reading skills.

Iowa Every Pupil Test of Basic Study Skills. Iowa City:

State University of Iowa. Grades VI, VII, and VIII. Test of reading charts and graphs, indices, and use of basic references.

Metropolitan Achievement Test. Yonkers: World Book Company.

Tests of processes and problems.

New Stanford Achievement Test. Yonkers: World Book Company.

Grades II to IX. Tests of processes and problems.

Progressive Achievement Tests. Los Angeles: Southern California

School Book Depository. Grades IV to VI and Grades VII to IX. Tests of processes and problems.

Two defects are common to all these tests insofar as use in the Edmonton Public School System is concerned. Firstly, none of them has its items based directly on the Alberta courses in arithmetic. Secondly, the norms are not determined on the Edmonton school population.

Regarding the Analytical Scales of Attainment W J. Osburn reports that the "authors seem to have largely avoided such genuine quantitative relations as may be found in ratios, proportions, and series. The test seems to be a measure of arithmetic information. Its validity for quantitative relationships seems very doubtful
... The Vocabulary tests are open to question".⁶

Reporting on this same test G. M. Wilson says that "the general conclusion must be that the coverage of fundamental processes is inadequate for the diagnosis of difficulties and, therefore as a guide for teaching. The test can be used for only very general classification."⁷

The Progress Tests in Arithmetic Processes and the Progress Tests in Problem Solving by Leo J. Brueckner are evidently designed to measure pupil attainment by months. Since the proposed test is to include only the more important aspects of arithmetic neither of the above sets of tests can fulfill that requirement.

In the Compass Survey Tests there is careful grading for difficulty and careful distribution with respect to use of basic number facts. But Brownell suggests that "only the traditional outcomes of arithmetic instruction are measured and these imperfectly. That is to say, the emphasis is almost wholly upon computation".⁸ There are few verbal problems. Neither has an attempt been made to "get at arithmetical meanings or at social significance which children attach to the number ideas and skills which they possess."⁹ There is no information on the reliability of the test nor on the procedures used in the validation of the items. Its values would be chiefly in "securing a rough

measure of attainment in computational skills only".¹⁰

According to the manual which accompanies the Dominion Tests, they were designed primarily to "provide a reliable measure of achievement in arithmetic computation over a wide range of grades and ages".¹¹ Thiele points out, however, that the net result of focusing attention solely upon arithmetic computation can have only one outcome, and that is to make arithmetic a mechanistic drill subject. He also says that there are dangers in making wide use of a test in which arithmetic computation alone is measured.¹²

The Iowa Every-Pupil Test in Basic Arithmetic Skills and Basic Study Skills is "a departure from the traditional type of measurement in arithmetic which is usually restricted to abstract computation and problem solving".¹³ William Brownell finds that the vocabulary and fundamental knowledge section of the test "represents a serious attempt to evaluate the understanding of elements of arithmetical knowledge which are being steadily more widely accepted as outcomes of instruction."¹⁴ Although the items of the computation section are of the standard variety there appears to be one serious weakness in them. Undue stress has been put on denominate numbers. Seven out of eighteen questions in that section have been devoted to computation in this particular area. Although the manual accompanying this test is otherwise complete and helpful it lacks the data on the validity and the reliability of the tests. Leroy H. Schnell suggests that the test can serve excellent purposes when "the advanced battery is extended in scope to sample more of the work of the upper grades and the inaccurate and misleading statements are corrected".¹⁵

Of the Metropolitan Achievement Tests Harry Grove Wheat says that they "give a measure of achievement in general They are useful in determining quickly but roughly the classification of a large group of pupils. In the case

of a small group of individual pupils, they do not reveal as much as the teacher can discover through careful observation. " 16

The arithmetic section of the Stanford Achievement Tests has two parts, - arithmetic reasoning and arithmetic computation. No part of either battery is devoted to the testing of arithmetic vocabulary or fundamental knowledge. Three questions of the arithmetic reasoning section of the test for the intermediate grades are repeated in the test for the advanced grades. This is a weakness if the tests are to be given in consecutive years to a grade six and a grade seven class. There is no evidence that the items of the test are arranged in their order of difficulty.

C. L. Thiele, reporting on the Progressive Achievement Tests says that the arithmetic tests of this battery "are wholly inadequate as measures of the principles and generalizations of arithmetic In view of the sampling methods alone, it would be difficult to accept the tests as measures which indicate the educational status of an arithmetic program, or to the extent to which both groups and individuals have mastered larger topics and specific skills in arithmetic." 17

As has already been suggested each test mentioned above has certain defects or limitations which make it unsuitable for extensive use in the Edmonton Schools. It was thought advisable therefore to construct another test in which the objectionable features referred to would be eliminated. Then, too, the norms of achievement obtained from it would have real meaning for teachers and administrators using the test.

CHAPTER III

PLANNING THE TEST

This test was planned to embody the characteristics of a good survey test discussed in the first chapter. Some other general considerations were regarded as being of prime importance. To make the test valid it was decided that the questions should be of sufficiently wide range to include work from grade four through grade eight and to cover the minimum requirements of these grades in vocabulary work, computational skills and problem solving. To arrange the test items in ascending order of difficulty the method of scaling items which employs the sigma of the distribution as the unit of measurement was used.¹⁸ The sigma units or sigma deviation scores were found by dividing the deviation of the score of each item from the mean by the standard deviation. These, then, constitute a means of measurement of item difficulty in terms of the variability of the group. This procedure was chosen as it has been shown that when the ability being measured is assumed to be normally distributed, sigmas rather than percentage differences are the better indices of differences of difficulty.¹⁹ A second reason for its selection was that with the variability of the sample used as a scaling unit the test items can be spaced at definite points along a difficulty scale. For convenience in scaling by this method negative three times sigma was used as an arbitrary zero point from which performance could be measured.

To facilitate administration it was decided to construct the test in alternative and comparable forms. Since this was primarily to be a survey, not a diagnostic test, the score would give a child's general level of attainment in arithmetic. Diagnosis, however, would be possible to the degree to which the test is divided into components.

Most current tests have no section evaluating arithmetic vocabulary and fundamental knowledge. The first sub-section of this test was devoted to this important phase of instruction. The remaining two sub-sections tested computation and problem work. Since the problem sub-section aimed at testing reasoning ability the problems offer the student little computational difficulty. The number of items in each sub-test was limited to approximately thirty-five to permit the time of administration not to exceed thirty minutes.

A committee of teachers was formed for the purpose of constructing the test and administering it in its preliminary stages. In preparation for this work they examined a chart organizing by topic and grade the subject matter required by the Alberta course of study. Each sub-test contained many items ranging in difficulty from very easy to very hard. These sub-tests were given to small samples averaging forty pupils.

The percentage of pupils passing each item was computed. Those items which were answered correctly by eighty-five per cent or more of the pupils were rejected as being too easy. Items which were answered correctly by fewer than fifteen per cent were eliminated as being too difficult. The eighty-five per cent and fifteen per cent limits were chosen because this
20
wide range of difficulty is the one recommended by test makers.

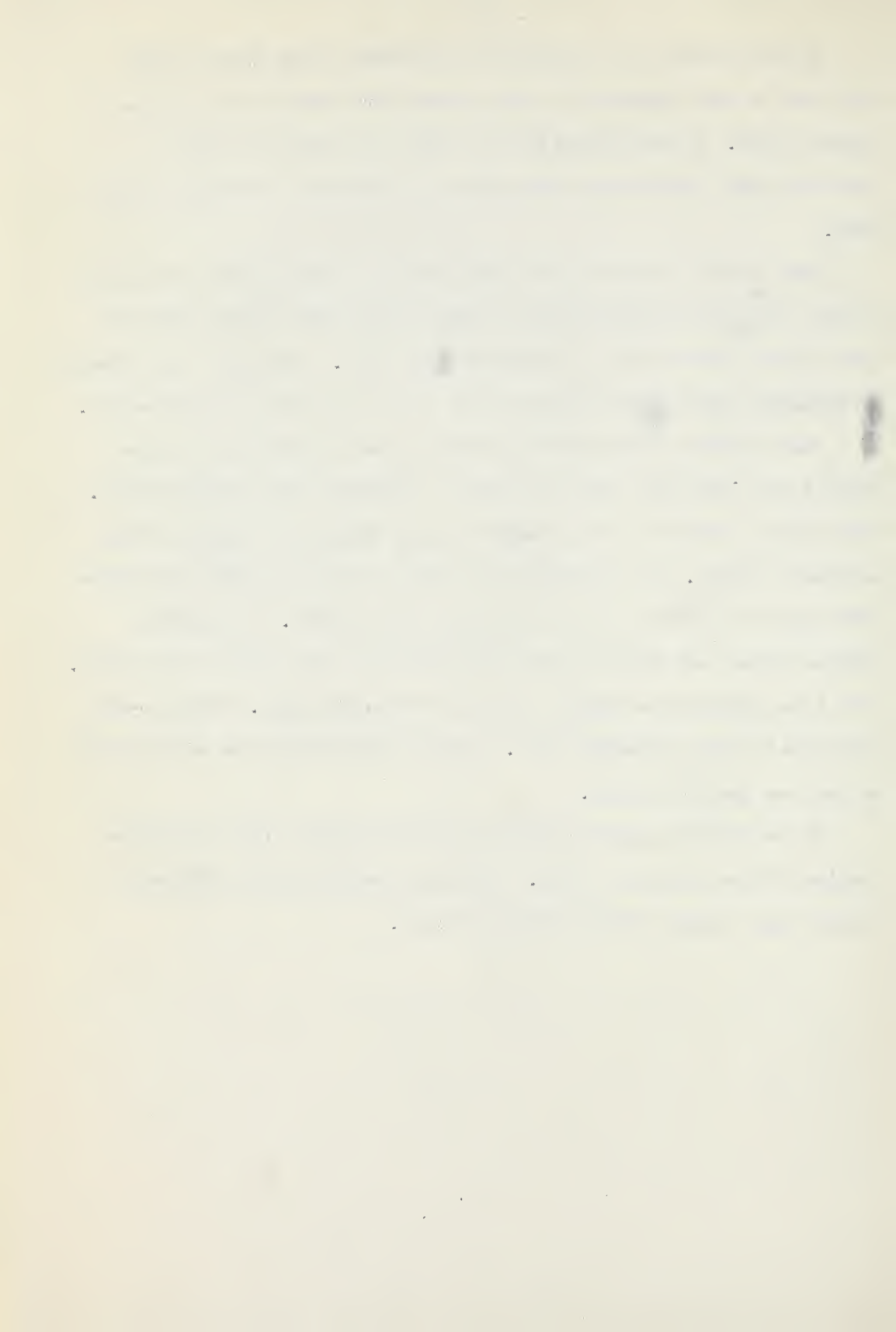
The relative difficulty of the remaining test items was then calculated in terms of their distance from the mean in sigma values. These difficulty ratings were next converted to revised sigma values by reference to a scale which used the arbitrary zero as the reference point, and the items were then rearranged in order of difficulty.

As the test was to be prepared in alternative forms twice as many questions as were required for each sub-test were selected from the remaining items. A consolidated test was made up of these in order to determine their difficulty rating after all grades had attempted to solve them.

From the data secured in the consolidated test the relative difficulty of each item was calculated again in terms of the sigma distance from the mean and the distance from an arbitrary zero point. Items were then arranged in ascending order of difficulty in each of the two forms of the sub-tests.

The completed survey test in its three sub-sections and in its two forms A and B was given next to a sample of Edmonton Public School pupils. This sample consisted of five hundred students chosen by using the method of random numbers. Four classrooms for each of the five grades and twenty-five pupils from each of these classrooms were selected. No pupils or classes taking part in any of the preliminary work were used in this sample. Form A was administered towards the end of the ninth month. Each sub-test was given on three successive days. One week later Form B was administered to the same group of pupils.

In the following chapter detailed results obtained from the administration of Form A only are given. The Form B results are not tabulated because they parallel closely those of Form A.



CHAPTER IV

TEST RESULTS OF THE FIRST ADMINISTRATION

Tables I to III, inclusive, show the pupil attainment by grades on the first administration of Form A to the sample of five hundred towards the end of the ninth month. The grade is given at the top. In Table I the first column under the grade four section shows the total number of questions on each of the sub-tests. Column two lists the raw scores obtained on the vocabulary and fundamentals test. The third column indicates the raw scores obtained on the computation test. The last column gives the raw scores of the problem test. The last three rows give the possible score, the number of pupils who took the test, and the median score of each sub-test respectively. Information relating to the other grades may be read in a similar manner from Tables I to III.

TABLE I.--GRADE ATTAINMENT IN VOCABULARY AND FUNDAMENTALS,
COMPUTATION, AND PROBLEM SOLVING ON THE FIRST
ADMINISTRATION OF THE TEST TO THE RANDOM SAMPLE
OF FIVE HUNDRED PUPILS.

FORM A

GRADE FOUR				GRADE FIVE			
Items	TEST 1	TEST 2	TEST 3	Items	TEST 1	TEST 2	TEST 3
Correct	V and F	Comp.	Prob.	Correct	V and F	Comp.	Prob.
30				30			
29				29			
28				28	1		
27				27	1		
26				26	1		
25				25	3		
24				24	2		
23				23	5		
22	1			22	8		
21	0			21	11		
20	3			20	10		
19	4			19	7	1	
18	7			18	10	0	1
17	8			17	5	2	0
16	4			16	7	4	2
15	8			15	7	4	6
14	11		1	14	6	7	6
13	8		0	13	9	13	3
12	14		1	12	6	16	6
11	8		1	11	0	14	9
10	6		4	10	0	9	12
9	6	5	3	9	0	8	18
8	3	17	12	8	0	10	7
7	4	12	14	7	1	5	11
6	2	21	11	6		2	8
5	1	18	15	5		3	7
4	1	11	20	4		1	4
3	0	5	9	3		0	
2	1	9	5	2		1	
1		2	4	1			
0				0			
Possible Score	40	39	26	Possible Score	40	39	26
No. of Pupils	100	100	100	No. of Pupils	100	100	100
Median	13.5	6.25	5.80	Median	18.9	11.8	9.72

TABLE II.--- GRADE ATTAINMENT IN VOCABULARY AND FUNDAMENTALS,
COMPUTATION, AND PROBLEM SOLVING ON THE FIRST
ADMINISTRATION OF THE TEST TO THE RANDOM SAMPLE
OF FIVE HUNDRED PUPILS

FORM A

GRADE SIX				GRADE SEVEN			
Items	TEST I	TEST 2	TEST 3	Items	TEST I	TEST 2	TEST 3
Correct	V & F	Comp.	Prob.	Correct	V & F	Comp.	Prob.
37				37		1	
36				36	4	1	
35		2		35	0	0	
34	2	0		34	1	2	
33	1	0		33	5	2	
32	2	3		32	7	5	
31	2	2		31	5	4	
30	7	4		30	13	7	
29	5	7		29	8	4	
28	5	7		28	9	3	
27	11	3		27	7	5	
26	16	13		26	8	10	
25	13	12		25	8	6	
24	13	10		24	2	4	
23	7	7	1	23	4	5	4
22	1	7	4	22	5	6	5
21	4	3	2	21	5	9	9
20	4	6	1	20	3	8	8
19	5	3	5	19	4	5	4
18	0	3	12	18	1	3	9
17	0	2	1	17		2	8
16	0	1	11	16		1	8
15	0	2	9	15		0	10
14	1	1	11	14		1	6
13		0	8	13		3	11
12		0	9	12		1	5
11		0	10	11		0	3
10		0	4	10		0	3
9		0	5	9		1	2
8		0	3	8			0
7		0	1	7			4
6		1	0	6			
5			0	5			
4			2	4			
Possible Score	40	39	26	Possible Score	40	39	26
No. of Pupils	99	99	99	No. of Pupils	99	99	99
Median	26.1	25.3	14.68	Median	28.3	25.2	16.69

TABLE III.-- GRADE ATTAINMENT IN VOCABULARY AND FUNDAMENTALS,
COMPUTATION, AND PROBLEM SOLVING ON THE FIRST
ADMINISTRATION OF THE TEST TO THE RANDOM SAMPLE
OF FIVE HUNDRED PUPILS.

FORM A

GRADE EIGHT

Items Correct	TEST I V & F	TEST 2 Comp.	TEST 3 Prob.
39	1		
38	1	1	
37	1	1	
36	1	2	
35	4	2	
34	2	1	
33	9	6	
32	8	9	
31	11	9	
30	9	5	
29	8	9	
28	6	5	
27	14	9	
26	6	7	2
25	7	7	2
24	3	3	3
23	6	3	0
22	2	2	10
21	1	1	12
20		2	16
19		5	16
18		5	10
17		1	7
16		0	8
15		1	3
14		2	2
13		1	5
12		0	5
11		1	2
10			2
9			0
8			0
7			1
6			
Possible Score	40	39	26
No. of Pupils	100	100	100
Median	29.6	28.0	19.31

Table IV shows the total achievement scores on the three sub-tests of Form A. The total achievement score on the three sub-tests shall hereafter be termed the composite score. The composite score, arranged in intervals of five, is shown in column one. Columns two to six give the number of pupils, by grades, who obtained the totals indicated in column one.

TABLE IV.-- GRADE ATTAINMENT BY COMPOSITE SCORES ON THE FIRST ADMINISTRATION OF THE TEST TO THE RANDOM SAMPLE OF FIVE HUNDRED PUPILS.

FORM A						
Items Correct	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	TOTAL
105-109						0
100-104						0
95- 99				1	2	3
90- 94				3	5	8
85- 89			5	3	10	18
80- 84			3	12	18	33
75- 79			6	12	19	37
70- 74			12	15	15	42
65- 69			17	12	14	43
60- 64			26	15	6	47
55- 59		3	17	9	5	34
50- 54		7	7	11	2	27
45- 49		18	4	3	4	29
40- 44	2	18	1	3		24
35- 39	3	18	0			21
30- 34	16	22	0			38
25- 28	28	10	0			38
20- 24	28	3	1			32
15- 19	13	1				14
10- 14	9					9
5- 9	0					0
0- 4	1					1
Possible Score	105	105	105	105	105	105
No. of Pupils	100	100	99	99	100	498
Median	24.8	38.9	63.5	68.5	76.1	

CHAPTER V

EVALUATION OF THE TEST

In a good survey test the increment in learning from grade to grade is assumed to be relatively constant. Therefore the median scores by grades obtained from either of the sub-tests or from the total achievement of the complete test should appear graphically in an approximately straight line.

An attempt will now be made to evaluate the test with respect to the constancy of the increment in learning as indicated by the differences between the median scores for successive grades. This evaluation will consider the data secured from the administration of Form A of the test and will deal with the three sub-tests and the test as a whole. Only the data concerning the whole test will be considered in the case of Form B.

As the test was first administered towards the end of the ninth month of the school year each grade median is designated by a symbol to indicate this. The symbol 4.9 is to be interpreted as the ninth month in the fourth grade. The other symbols are read in a similar manner.

Table V tabulates by grades the median scores of each sub-test of Form A as well as the differences between these medians.

TABLE V - MEDIAN SCORES AND MEDIAN SCORE DIFFERENCES OF THE VOCABULARY AND FUNDAMENTALS, COMPUTATION AND PROBLEM TESTS OF FORM A ON THE FIRST ADMINISTRATION TO THE RANDOM SAMPLE OF FIVE HUNDRED PUPILS.

Voc. and Fund.			Computation		Problems	
Grade	Median	Difference	Median	Difference	Median	Difference
FOUR (4.9)	13.5		6.25		5.80	
FIVE (5.9)	18.9	5.4	11.8	4.35	9.72	3.92
SIX (6.9)	26.1	7.2	25.3	13.5	14.68	4.96
SEVEN (7.9)	28.3	2.2	25.2	- 0.1	16.69	2.01
EIGHT (8.9)	29.6	1.3	28.0	2.8	19.31	2.62

From this table we see that in the Vocabulary and Fundamentals sub-test the median difference between the grade 4.9 and grade 5.9 results is 5.4. A slightly larger difference is shown between the grade 5.9 and the grade 6.9 results where the difference is 7.2. There is a very definite drop from this figure at the grades 6.9 and 7.9 levels. The difference here is 2.2. A still further decline is shown between the grade 7.9 and the grade 8.9 medians where the difference is 1.3.

Figure 1 is a graph of the median scores by grades of each sub-test. The vertical axis indicates the score in questions correct. The horizontal axis shows the grades. For ease of comparison the graphs of the three sub-tests are constructed on the same sheet. The Graph of the Vocabulary and Fundamentals test is shown in red; that of the Computation test is in green; the Problem test is pictured in blue.

For the grade 6.9 median on the Vocabulary and Fundamentals sub-test the graph shows a slight deviation upward from the expected median which may have resulted from the questions selected being relatively easy for the average grade 6.9 student.

There is an indication that the items on this sub-test were not selective enough at the grade 7.9 level. Evidently there were an insufficient number of easy items of strictly grade seven difficulty to raise the median of the class to its proper level and yet be discriminative enough to prevent most of the grade six pupils from solving them.

This appears to be true of the grade eight questions as well. There were too few easy items that grade 8.9 pupils could solve which were sufficiently difficult for the grade 7.9 pupils.

The graph shows that the greatest deviation from linearity in the Vocabulary and Fundamentals sub-test of Form A was at the grade 7.9 and 8.9 levels.

Of the three sub-tests of Form A the greatest variation in increment from grade to grade is shown in computation. The median difference between the grade 4.9 and the grade 5.9 medians on this test is 4.35. The difference between the grade 5.9 and the grade 6.9 medians is 13.5. This difference is slightly more than three times the difference between the medians of the two previous grades. It is obviously too great a difference to approach linearity.

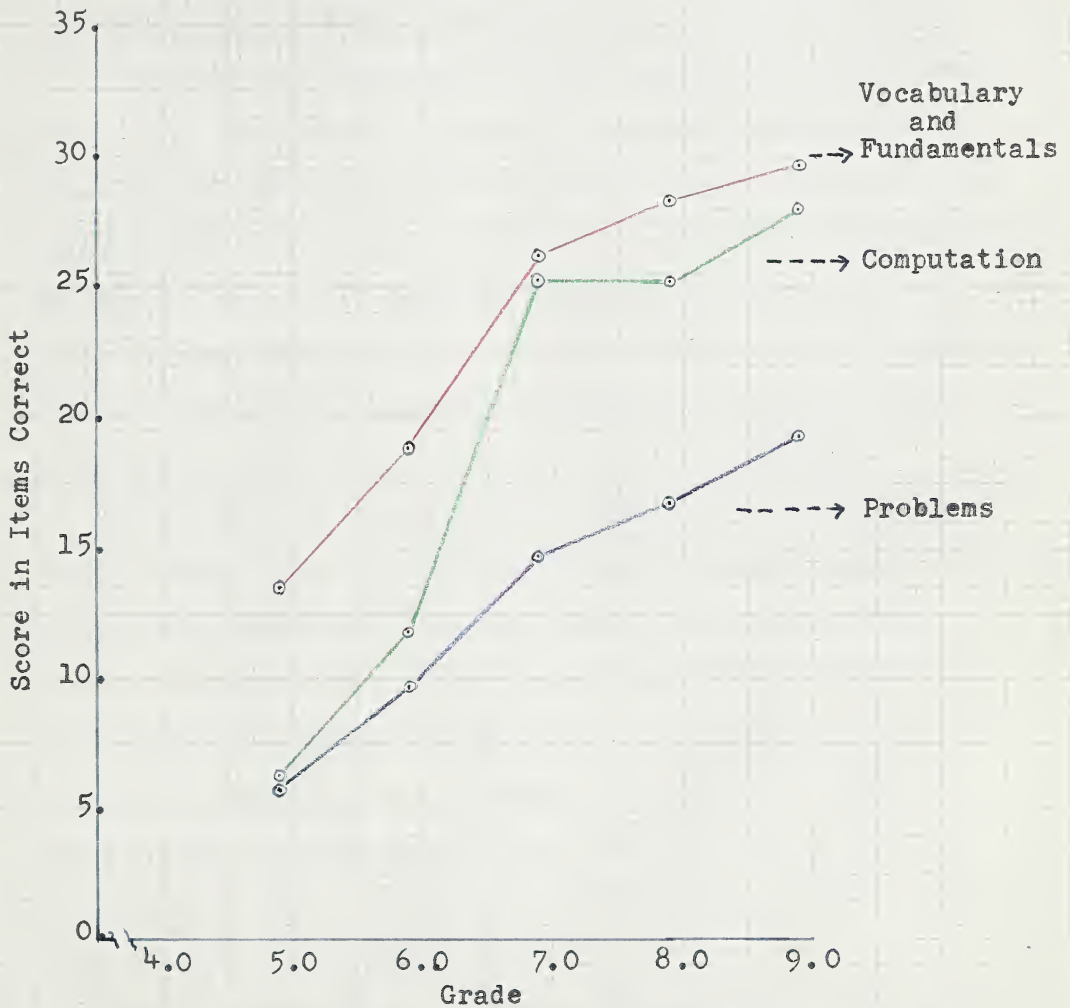
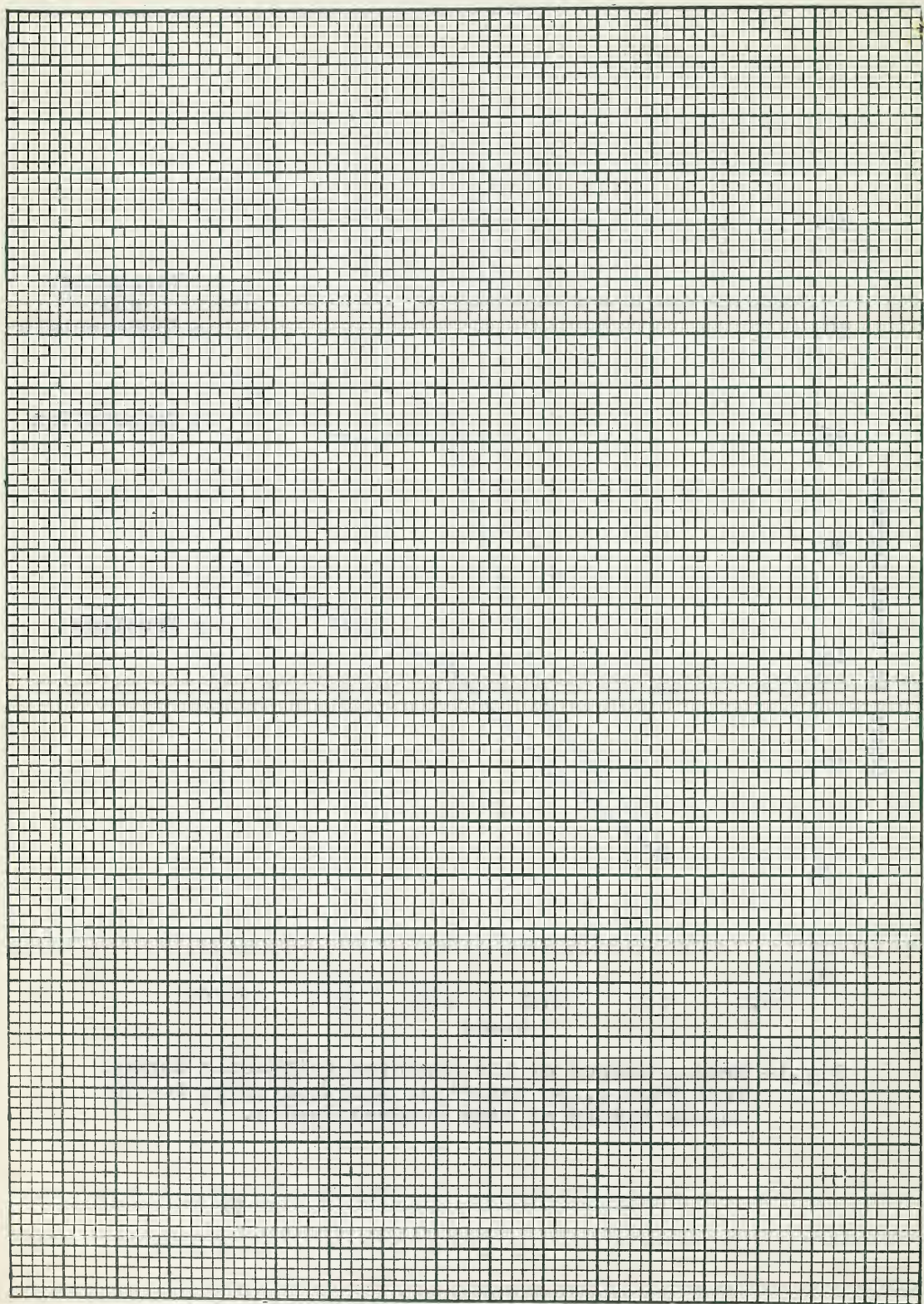


Fig.1- Median Scores of the Edmonton Arithmetic Survey Test Form A, on the First Administration to the Random Sample of Five Hundred Pupils.



An abrupt change is noticed again between the grades 6.9 and 7.9 medians. The grade 7.9 median drops to a point 0.1 below that of the grade 6.9 group. Although the difference of 2.8 between the grades 7.9 and 8.9 medians is considerably larger than the difference between the grades 6.9 and 7.9 medians it still is slightly low.

Graphically the grade medians of this sub-test are shown in green in Figure 1. The extreme deviations of the grade 6.9 median would indicate that the questions selected on the computation sub-test are too easy for grade 6.9 students. Since the grade 8.9 median is slightly below what was expected it would seem that there are insufficient easy items of grade eight level chosen for this sub-test. Such wide differences as noted in the computation sub-test no doubt have a definite effect on the total score and the median score of each grade.

The problem test medians of Form A show fairly even differences between grades. There is a difference of 3.92 between the grade 4.9 and the grade 5.9 medians. A slight increase over this is shown between grade 5.9 and grade 6.9 groups as their median difference is 4.96. There is a slight decrease in this to a difference of 2.01 between the grades 6.9 and 7.9 medians. The difference between the grade 7.9 and the 8.9 medians is 2.62. The data from this sub-test would indicate that a comparatively good selection of items for each grade was made for the problem sub-test.

Figure 1 shows the graph of these medians charted in blue. The grade 6.9 median is slightly above while the grade 7.9 and the grade 8.9 medians are slightly below what might be considered a "best-fitting" line for the median scores of the Problem sub-test.

No attempt has been made in this study to tabulate the data of each sub-test of Form B. Nevertheless a careful study of the data of Form B revealed the same general weaknesses in it as are found in Form A.

Table VI gives the medians and the median differences by grades of the composite scores for both forms of the test. The information as to Form A or Form B is listed under their respective headings.

TABLE VI -- THE MEDIAN OF THE COMPOSITE SCORES AND THE DIFFERENCES OF THE COMPOSITE SCORE MEDIAN ON THE FIRST ADMINISTRATION OF FORM A OF THE TEST TO THE RANDOM SAMPLE OF FIVE HUNDRED PUPILS.

FORM A			FORM B	
GRADE	MEDIAN	DIFFER.	MEDIAN	DIFFER.
FOUR (4.9)	24.8		24.9	
FIVE (5.9)	38.9	14.1	40.6	15.7
SIX (6.9)	63.8	24.9	64.1	23.5
SEVEN (7.9)	68.5	4.7	65.6	1.5
EIGHT (8.9)	76.1	7.6	75.4	9.8

The difference between the medians of the composite score of the grade 4.9 and 5.9 groups on Form A is 14.1. Between grade 5.9 and grade 6.9 groups the difference is 24.9. This difference is unduly large. There is a very definite drop to a difference of 4.7 between the grade 6.9 and the grade 7.9 medians and a slight rise to a difference of 7.6 questions between grade 7.9 and grade 8.9 medians.

Figure 2 shows this graphically with the Form A medians drawn in red. Since the median of the composite score of the grade 6.9 class is relatively high it is evident that the questions selected for this class on the three sub-tests were too easy. There is an indication from the medians of the grades 7.9 and 8.9 composite scores that the questions selected for these grades were too hard.

A comparison of the median differences by grades of the composite scores in both Form A and Form B shows that considerable care was taken in equating the items for the alternate forms of the test. The difference between the median scores of grade 4.9 and grade 5.9 groups is 14.1 in Form A and 15.7 in Form B. The differences between the grades 5.9 and the grade 6.9 medians are 24.9 and 23.5 for Form A and Form B respectively. At the grade six and seven levels the choice of questions is not quite so good since the difference between the medians of the grade 6.9 and 7.9 groups is 4.7 for Form A and 1.5 for Form B. For the Grade 7.9 and the grade 8.9 medians a difference of 7.6 is indicated in Form A and one of 9.8 in Form B.

The graph in Figure 2 illustrates this fact. Form B medians are shown in green. There is evidence that the two forms are comparable in difficulty. Only at the grade 7.9 level does there appear to be any appreciable divergence in the difficulty of the questions selected. Even this is slight however as the difference between the medians of the composite scores is only a matter of 2.9 questions.

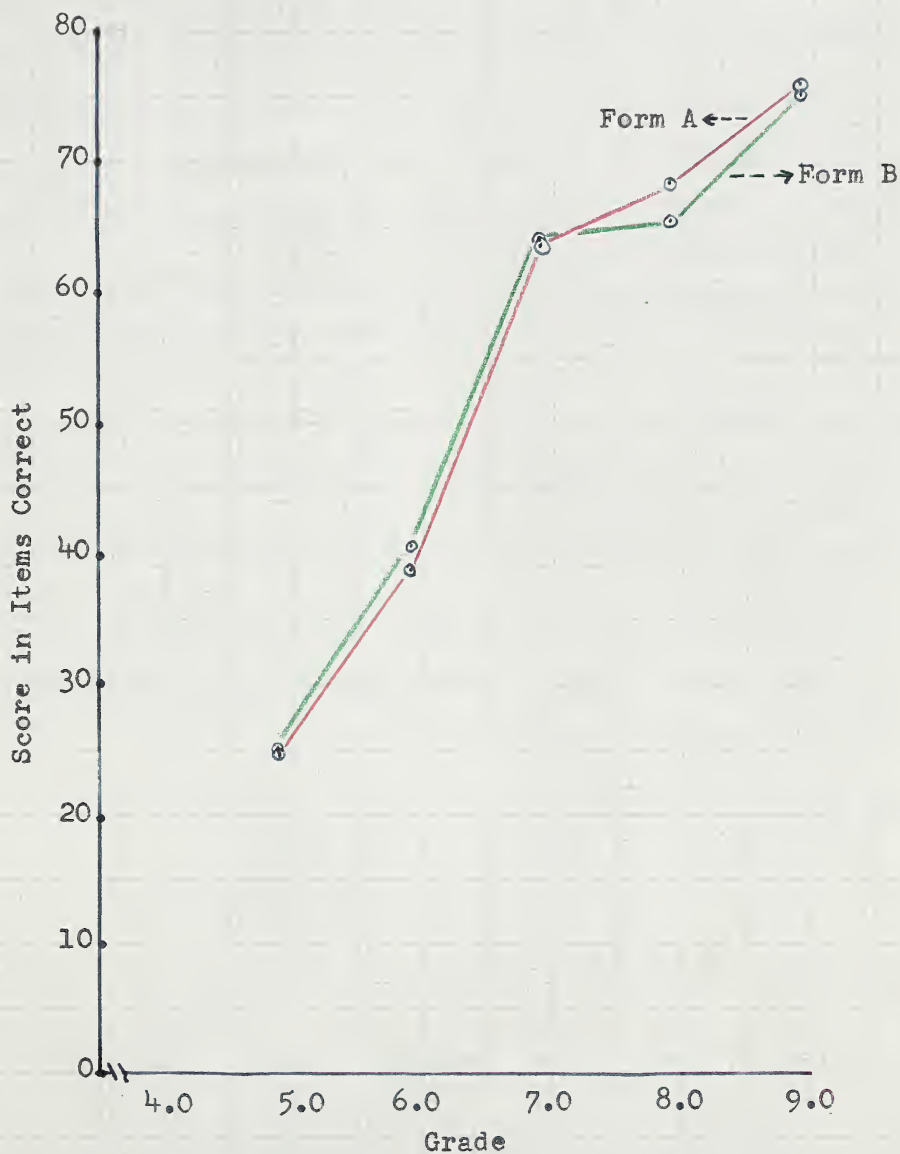
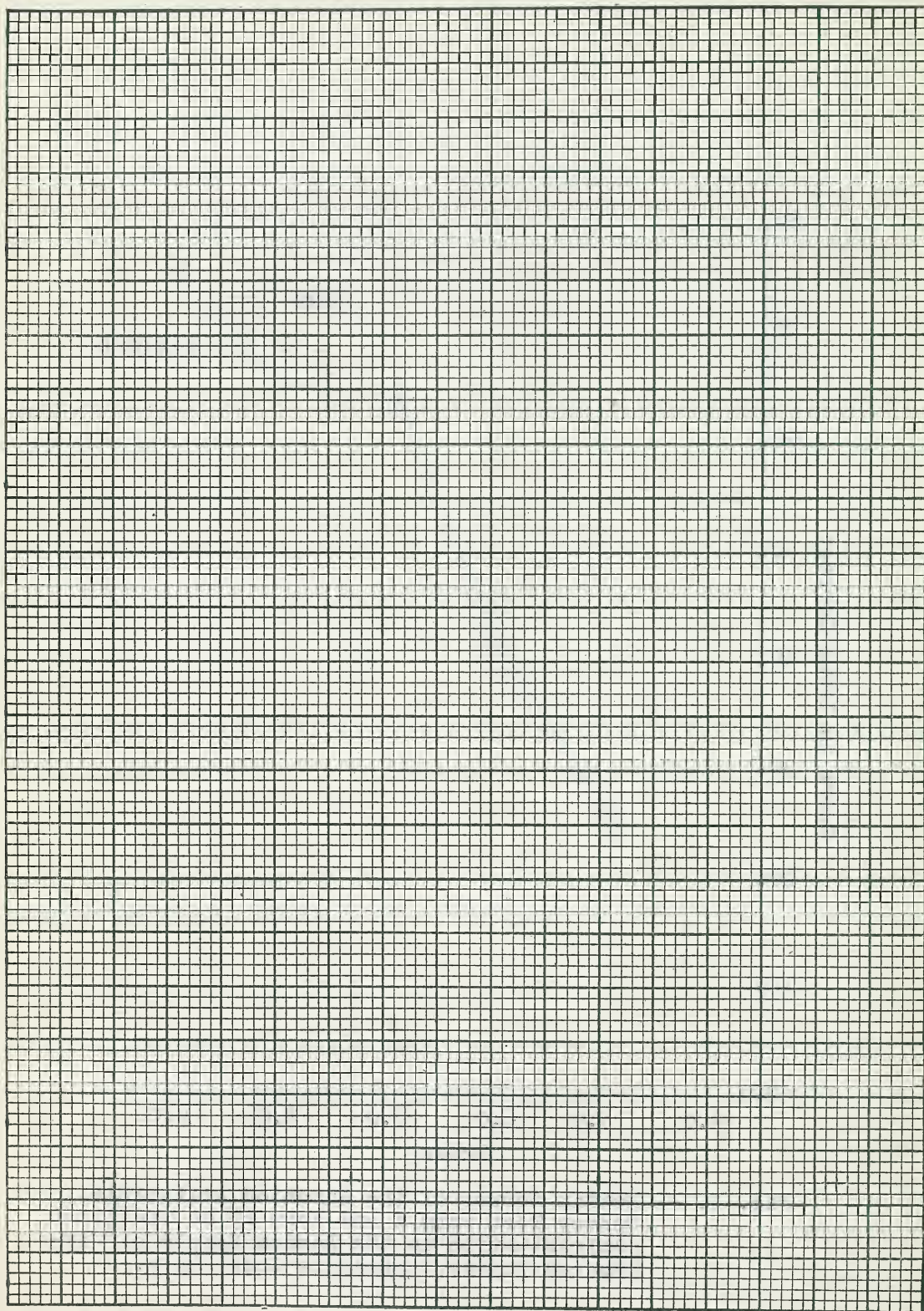


Fig. 2. -- Median Scores of the Edmonton Arithmetic Survey Test Form A and Form B, on the First Administration to the Random Sample of Five Hundred Pupils, Composite Score Data.



The over-all picture as given by the results obtained from the test suggests that the items it contained were not selective enough at the grades 6.9, 7.9 and 8.9 levels to insure a relatively constant increase in the differences between the median scores from grade to grade. There is evidence of a decided increase in the differences between the median scores at the grade 6.9 level and a definite falling off at both the grade 7.9 and the grade 8.9 levels. This fact is true of each of the sub-tests as well as the test as a whole. However the data does reveal the fact that questions on the alternate and comparable forms were carefully and accurately selected.

CHAPTER VI

PLANNING THE REVISION OF FORM A

The results of both forms of the original test were unsatisfactory since linearity was not achieved when the various median scores were graphed. In the Vocabulary and Fundamentals sub-test of Form A the graph deviated from linearity at the grades 6.9, 7.9 and 8.9 levels. There was a wide deviation in the Computation test results of this form at the grade 6.9 level and a slight deviation at the grade 8.9 level. The deviation from linearity is least in the Problem sub-test of Form A with the grade 6.9 median slightly above and the grades 7.9 and 8.9 medians slightly below the expected medians for these grades. In the graph of the composite score medians of this form of the test the deviation from the expected median is greatest at the grade 6.9 level with less deviation at the grade 7.9 and 8.9 levels. As the results of Form B parallel closely those obtained in Form A they were not tabled nor graphed.

Because of these unsatisfactory results it was decided to revise Form A of the test to get a more constant increment in achievement from grade to grade.

The original data of each sub-test of Form A were then carefully studied and items which might have been responsible for the erratic behaviour of the different graphs deleted. Among the reasons for questions being discarded were the failure of a question to discriminate between grade levels, the possibility of a student guessing the correct answer either by the manipulation of numbers or by the chance offered by a multiple choice question, the fact that a question did not discriminate well or that it discriminated only fairly well and at the same time used an undue amount of space on the test paper, the possibility of a question being obsolete or impractical, and the awkwardness of putting a question on the test paper because it was accompanied by a rather

involved diagram. The items which had discriminated well between the different grades were retained.

To replace the deleted problems others of approximately similar difficulty were needed. To secure such problems a supplementary test was prepared.

Since the grades four and five results on the original test had proven fairly satisfactory it was felt that questions used on the supplementary test should be prepared for grades six, seven, and eight only. In the preparation of this supplementary test an attempt was made to keep the questions as strictly as possible to new material listed in the curriculum for grades seven and eight. By this procedure it was hoped that the grade six medians would be lowered and the grades seven and eight medians would be raised to a level that would show approximately equal increments between these three grade medians.

This supplementary test was given to three hundred pupils, one hundred in each of grades six, seven and eight. The schools from which these pupils were chosen and the pupils whose marks were used in recording the data of the supplementary test were selected by the method of random numbers.

The data secured from this test were critically reviewed. Then questions which discriminated most effectively between the pupils of grades six and seven and seven and eight were chosen from it. The selected questions were substituted for the ones previously deleted from the original test. This resulting test was called the Edmonton Survey Test in Arithmetic Form A, Revised.

Table VII shows the grade attainment of each item that was deleted from Form A, Test 1, Vocabulary and Fundamentals. Column one indicated the rank of each question deleted. Column two shows the number of pupils from grade four that obtained the correct answer for each question in

column one. The succeeding columns give the results obtained in grades five, six, seven and eight respectively. The total number attempting each question is shown in the last row.

TABLE VII - GRADE ATTAINMENTS IN THE ITEMS DELETED FROM FORM A, VOCABULARY AND FUNDAMENTALS.

ITEM NO.	FOUR (4.9)	FIVE (5.9)	SIX (6.9)	SEVEN (7.9)	EIGHT (8.9)
18	0	13	85	86	95
19	25	23	91	85	94
21	24	52	75	69	60
23	21	11	76	76	78
24	28	47	70	70	71
31	9	14	39	50	52
32	10	30	72	37	26
34	11	25	45	32	41
37	0	4	3	6	8
38	0	1	1	6	7
No. of Pupils	100	100	99	99	100

The grade attainment in the items selected from the vocabulary and fundamentals section of the supplementary test for use in the revised test is shown in Table VIII. This table is to be read and interpreted in the same way as Table VII. It is to be noted that the test was not given to grade four or grade five.

TABLE VIII - GRADE ATTAINMENT IN ITEMS SELECTED FROM THE SUPPLEMENTARY TEST IN VOCABULARY AND FUNDAMENTALS

Item No.	FOUR (4.9)	FIVE (5.9)	SIX (6.9)	SEVEN (7.9)	EIGHT (8.9)
6	0	0	45	91	84
7	0	0	26	69	82
12	0	0	10	26	76
14	0	0	16	9	50
No. of Pupils	100	100	100	100	100

Table IX shows the grade attainment in items deleted from Form A,
Test 2, Computation.

TABLE IX - GRADE ATTAINMENT IN ITEMS DELETED FROM FORM A, COMPUTATION.

Item	FOUR (4.9)	FIVE (5.9)	SIX (6.9)	SEVEN (7.9)	EIGHT (8.9)
12	1	7	88	83	83
13	0	5	88	81	86
16	1	2	89	87	88
19	1	14	82	87	83
20	-	2	65	70	74
21	1	14	73	69	68
22	1	26	60	48	61
26	1	5	82	78	75
27	0	3	72	60	67
29	0	7	63	55	60
30	0	1	64	56	64
35	0	0	37	34	24
38	0	0	1	10	18
39	0	1	0	6	3
No. of Pupils	100	100	99	99	100

Table X shows the grade attainment in items selected from the supplementary test in Computation.

TABLE X - GRADE ATTAINMENT IN ITEMS SELECTED FROM THE SUPPLEMENTARY TEST IN COMPUTATION.

Item No.	FOUR (4.9)	FIVE (5.9)	SIX (6.9)	SEVEN (7.9)	EIGHT (8.9)
4	0	0	63	86	85
9	0	0	23	26	65
10	0	0	6	67	76
11	0	0	23	71	73
12	0	0	27	29	60
15	0	0	3	38	57
16	0	0	2	4	57
21	0	0	3	6	41
22	0	0	0	30	59
No. of Pupils	100	100	100	100	100

Table XI shows the grade attainment in items deleted from Form A,
Test 3, Problems.

TABLE XI - GRADE ATTAINMENT IN ITEMS DELETED FROM FORM A,
PROBLEMS.

Item No.	FOUR (4.9)	FIVE (5.9)	SIX (6.9)	SEVEN (7.9)	EIGHT (8.9)
5	38	58	86	72	71
10	32	61	62	74	89
15	1	11	63	68	65
16	5	30	50	40	47
17	22	28	40	51	49
20	1	7	40	41	50
21	1	0	24	35	42
26	0	0	0	1	24
No. of Pupils	100	100	99	99	100

Table XII tabulates the attainment by grades of items selected from the supplementary test in Problems.

TABLE XII - GRADE ATTAINMENT IN ITEMS SELECTED FROM THE SUPPLEMENTARY TEST IN PROBLEMS.

Item No.	FOUR (4.9)	FIVE (5.9)	SIX (6.9)	SEVEN (7.9)	EIGHT (8.9)
8	0	0	35	76	81
9	0	0	40	56	85
6	0	0	31	81	97
7	0	0	30	47	79
12	0	0	12	69	81
16	0	0	1	52	79
18	0	0	2	5	66
15	0	0	0	5	59
No. of Pupils	100	100	100	100	100

At this point a prediction was made of the median scores of each sub-test, and of the medians of the composite scores by grades of Form A of the revised test. The reason for doing this was to judge as nearly as possible the results that might be expected when the revised test was given to another sampling of pupils. If graphing the predicted median scores indicated that these scores had satisfactory linearity the test could be assumed to be in a form which would produce reliable results if applied to the entire school system.

Accordingly the median of each sub-test was adjusted downward in proportion to the value of the questions deleted from the original test and upward according to the value of each question that was added from the supplementary test. The values of the questions deleted were determined from Table VII, Table IX, and Table XI while the values of those added were determined from Table VIII, Table X, and Table XII. To illustrate how the adjustments to the median scores were determined the median score of the grade 6.9 group on the Vocabulary and Fundamentals sub-test will be used. This score as read from Table V is 26.1. From Table VII the number of pupils at the grade 6.9 level getting question number eighteen right is 85. This is .85 of all the grade 6.9 group of pupils taking the test. Similarly the fraction of the grade 6.9 pupils who solved each of the questions in Table VII was computed. The sum of all these fractions is 5.57. As all these questions were deleted 5.57 was subtracted from 26.1 leaving a median of 20.53. In table VIII the sum of all the fractions indicated under the 6.9 group is .97. This is added to 20.53 to make a median of 21.50 which is the predicted median score for the grade 6.9 group as given in Table XIII.

The data of Table XIII shows the predicted median scores and median score differences of the three sub-tests of Form A, revised. Column one indicates the grade. Column two gives the predicted median of each grade on the Vocabulary and Fundamentals test. In column three are listed the differences between these medians. Column four and column six list the medians of the Computation test and the Problem test respectively. In column five and column seven are listed the median differences for the respective tests. The last row of the table shows the total number of questions on the new test. The total now stands at ninety-four questions instead of the original one hundred and five.

TABLE XIII - PREDICTED MEDIAN SCORES AND MEDIAN SCORE DIFFERENCES OF THE VOCABULARY AND FUNDAMENTALS, COMPUTATION AND PROBLEM TESTS OF FORM A, REVISED.

Grade	V & F	Differences	Comp.	Differences	Prob.	Differ.
FOUR (4.9)	12.39		5.55		4.80	
FIVE (5.9)	17.05	4.66	10.13	4.58	7.77	2.97
SIX (6.9)	21.50	4.45	17.05	6.92	12.34	4.57
SEVEN (7.9)	25.08	3.58	19.71	2.66	16.79	4.45
EIGHT (8.9)	27.20	2.12	24.00	4.29	21.21	4.42
Possible Score	34		34		26	

By observing the differences between the predicted median scores of the Vocabulary and Fundamentals test it is clearly seen that differences are relatively equal as they vary only from 4.66 between the grade 4.9 and 5.9 groups to 2.12 between the grade 7.9 and 8.9 groups.

There is not quite as much uniformity between the differences of the predicted median scores of the Computation test. At the grade 5.9 and 6.9 level the difference is predicted as 6.92 which is a deviation upward. In the case of the Problem sub-test there is a decided return to uniformity. The differences here vary from 2.97 between the grade 4.9 and grade 5.9 levels to 4.57 between the grade 5.9 and grade 6.9 levels.

Figure 3 represents the results which were obtained when the amended test data were graphed.

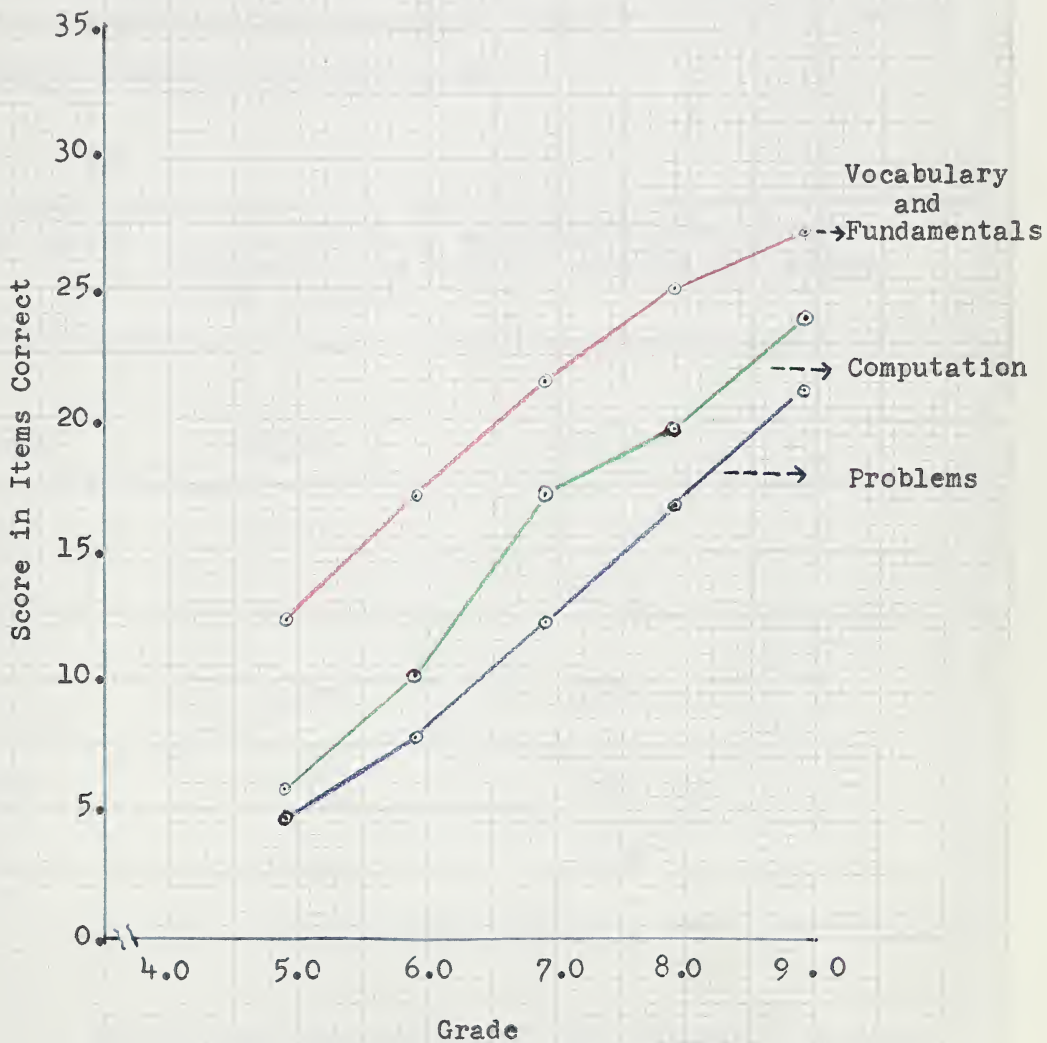


Fig. 3. -- Predicted Median Scores of the Edmonton Arithmetic Survey Test Form A, Revised.

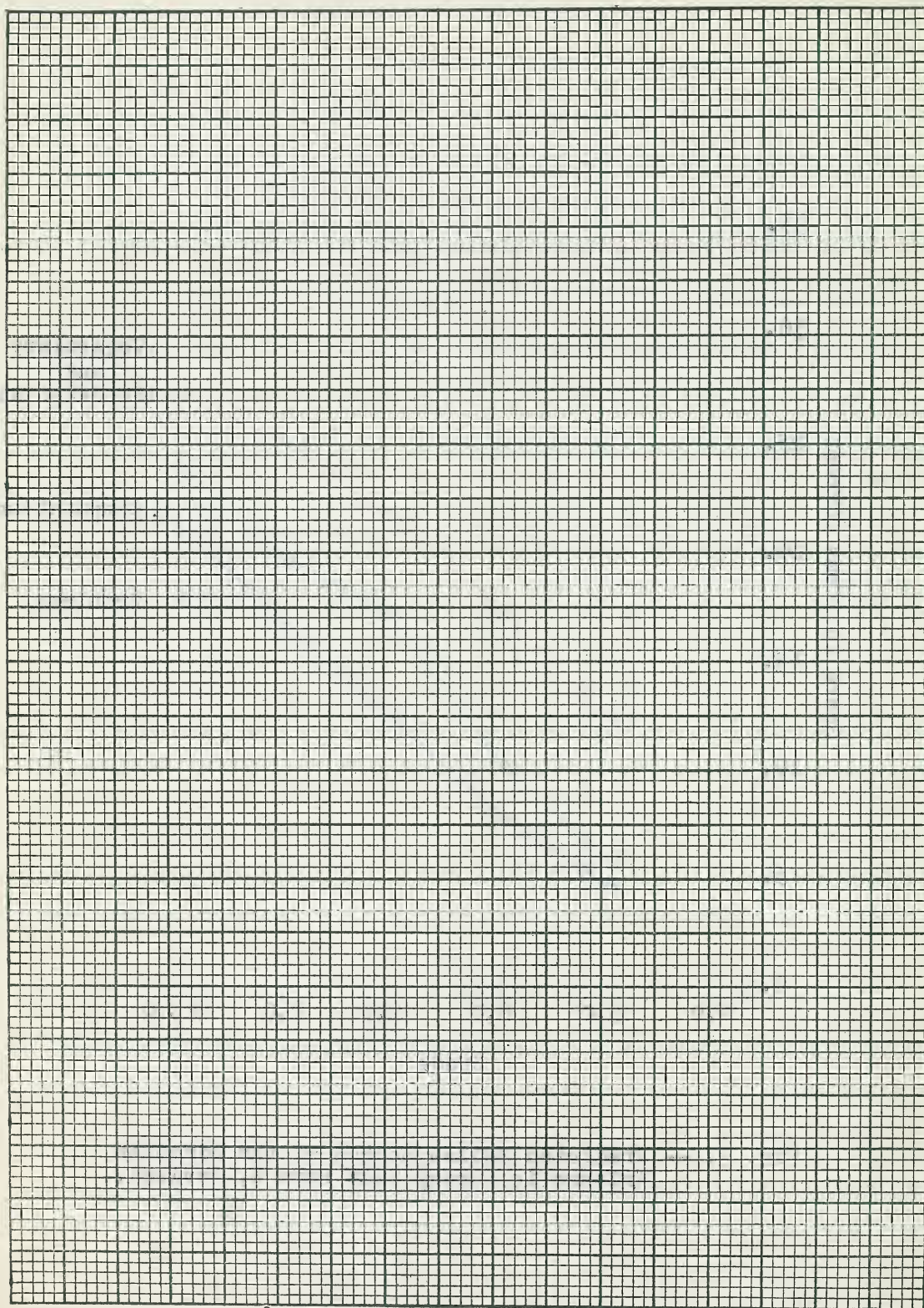


Table XIV gives the predicted medians of the composite scores of Form A, revised and the differences between these medians. These medians were obtained for each grade by adding the median of each sub-test together. Their differences as listed under column three show a relatively constant difference between the respective grades.

TABLE XIV. - PREDICTED MEDIANS OF THE COMPOSITE SCORES AND THE DIFFERENCES OF THE PREDICTED COMPOSITE SCORE MEDIANS OF FORM A, REVISED.

Grade	Median	Difference
FOUR (4.9)	22.74	
FIVE (5.9)	34.95	12.21
SIX (6.9)	50.89	15.94
SEVEN (7.9)	61.58	10.69
EIGHT (8.9)	72.41	10.83

Figure 4 shows this graphically. From the graph it is evident that the test, as predicted from the data of Table XIV, should now be in a form which will indicate a relatively constant increment in learning from grade to grade.

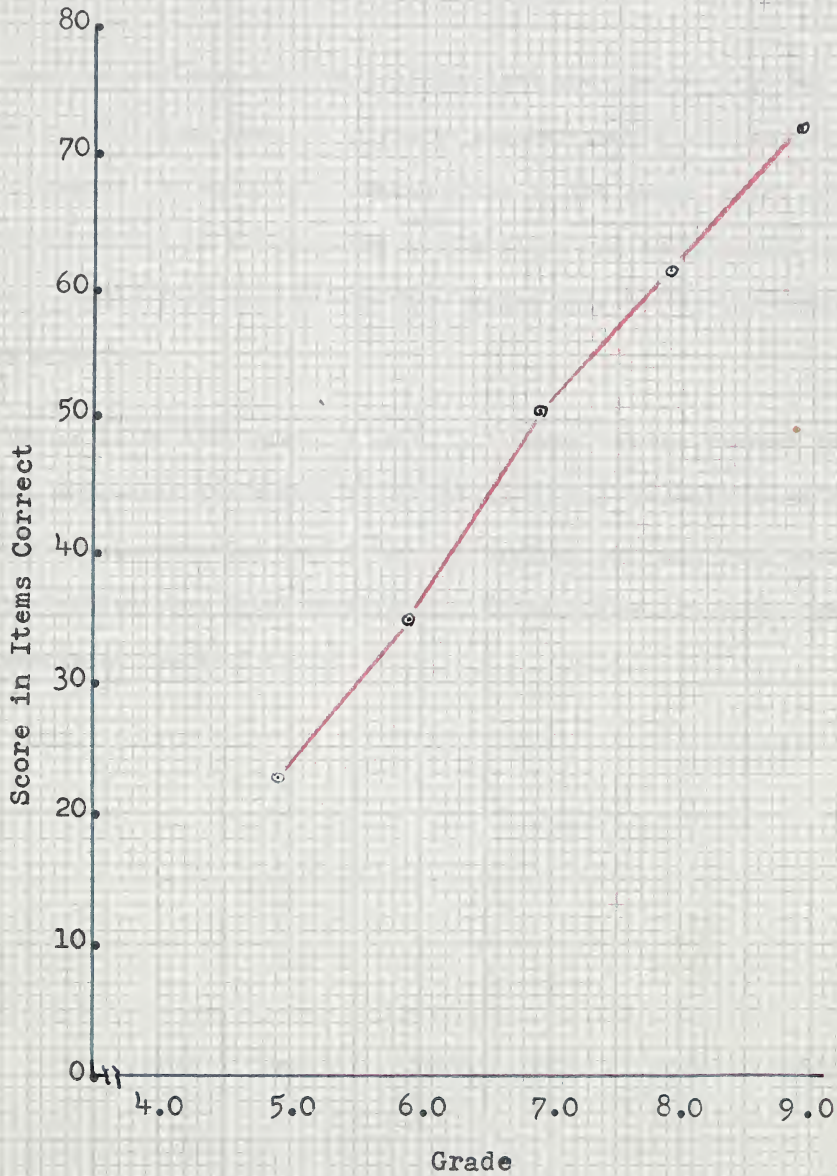
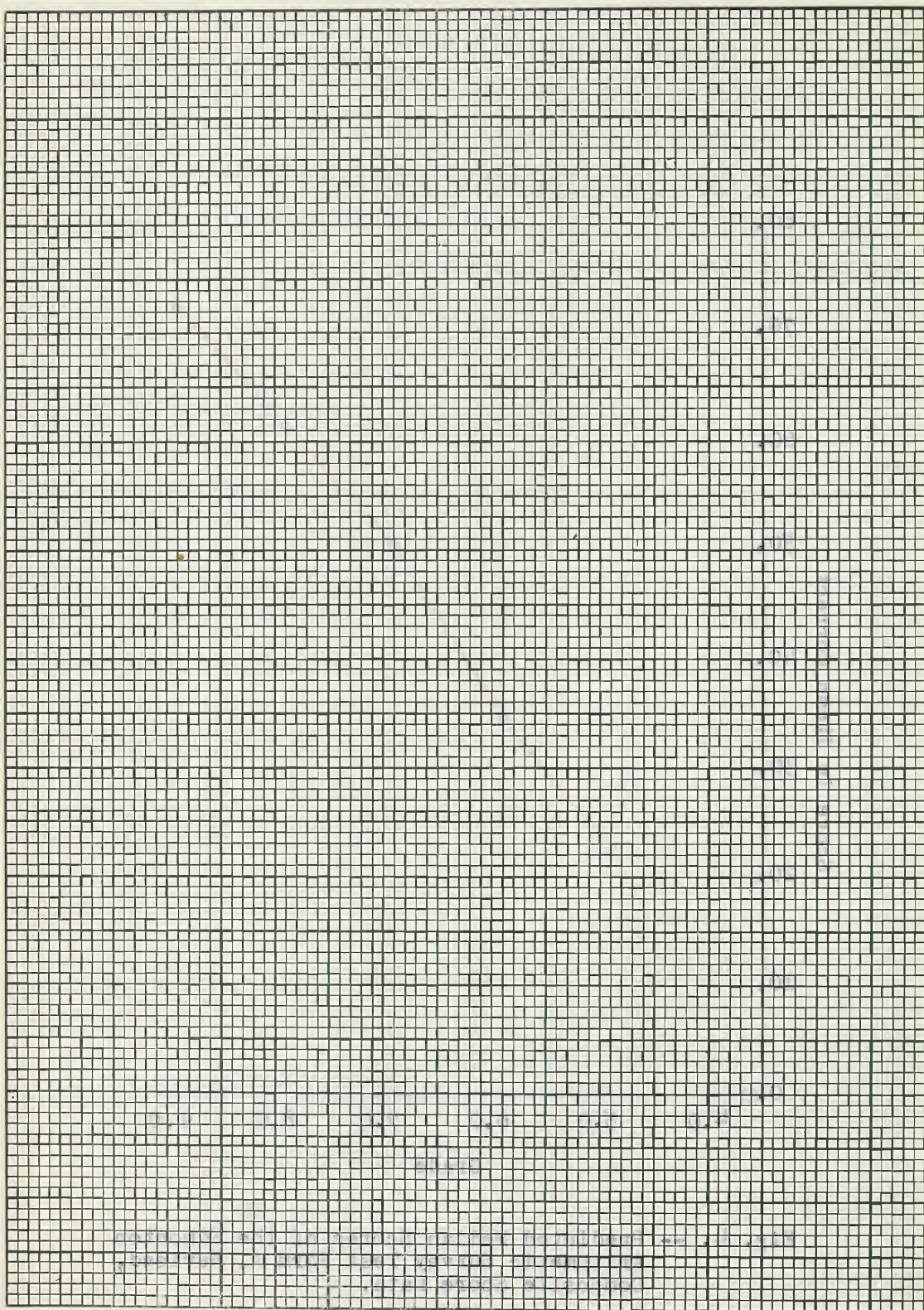


Fig. 4. -- Predicted Median Scores of the Edmonton Arithmetic Survey Test Form A, Revised, Composite Score Data.



CHAPTER VII

FINAL ADMINISTRATION OF THE TEST

When the revision of Form A of the test was completed it was mimeographed in the final form and given to another sample of five hundred pupils towards the end of the fourth month of the school year. This sample was chosen in the same way as the first and consisted of one hundred pupils from each of the five grades selected by the method of random numbers.

Tables XV to XVII give the pupil attainment on the revised test Form A. Note that the number of questions on the Vocabulary and Fundamentals test and the Computation test total thirty-four for each test while those for the Problem test total twenty-six. These tables are to be read in the same manner as Tables I to III.

TABLE XV -- GRADE ATTAINMENT IN VOCABULARY AND FUNDAMENTALS,
COMPUTATION AND PROBLEM SOLVING OF FORM A, REVISED.

FORM A							
GRADE FOUR				GRADE FIVE			
Items Correct	Test I V & F	Test 2 Comp	Test 3 Prob.	Items Correct	Test I V & F	Test 2 Comp	Test 3 Prob.
34				34			
33				33			
32				32			
31				31			
30				30			
29				29			
28				28			
27				27			
26				26			
25				25			
24				24			
23				23			
22				22			
21				21			
20				20	2		
19				19	3		
18				18	7		
17	1			17	9		
16	6			16	17		
15	8			15	12		
14	2			14	17		
13	12			13	11		
12	10			12	8	3	
11	13			11	5	1	1
10	11			10	4	8	0
9	6			9	3	17	3
8	8			8	1	24	6
7	9	1		7	1	18	11
6	5	12	3	6		7	15
5	5	22	7	5		7	21
4	2	23	24	4		8	23
3	1	15	27	3		0	10
2	1	18	25	2		5	7
1		6	9	1		0	3
0		3	5	0		2	0
No. of Pupils	100	100	100		100	100	100
Median	11.5	4.35	3.41		15.00	8.13	5.3
Possible Score	34	34	26		34	34	26

TABLE XVI-- GRADE ATTAINMENT IN VOCABULARY AND FUNDAMENTALS,
COMPUTATION AND PROBLEM SOLVING OF FORM A,
REVISED

FORM A

GRADE SIX				GRADE SEVEN			
Items correct	TEST I V & F	TEST 2 Comp.	TEST 3 Prob.	Items Correct	TEST I V & F	TEST 2 Comp.	TEST 3 Prob.
34				34			
33				33			
32				32			
31				31	1		
30				30	1		
29				29	1		
28				28	0		
27				27	4		
26				26	3		
25	1			25	6		
24	1			24	13	4	
23	6			23	13	4	
22	5			22	19	3	
21	8			21	10	2	2
20	11			20	2	8	1
19	13	1		19	5	14	1
18	20	1		18	5	8	2
17	8	3		17	6	12	8
16	10	6		16	4	12	5
15	7	11	1	15	2	11	4
14	3	15	3	14	2	1	13
13	3	16	6	13	1	8	9
12	2	16	3	12	1	4	8
11	1	13	10	11	1	4	11
10	1	6	9	10		1	9
9		3	16	9		3	6
8		6	13	8		1	4
7		2	12	7			6
6		1	13	6			5
5			6	5			5
4			6	4			1
3			1	3			
2			1	2			
1				1			
0				0			
No. of Pupils	100	100	100		100	100	100
Median	18.75	13.19	8.85		22.53	17.42	12.38
Possible Score	34	34	26		34	34	26

TABLE XVII -- GRADE ATTAINMENT IN VOCABULARY AND FUNDAMENTALS,
COMPUTATION AND PROBLEM SOLVING OF FORM A,
REVISED

FORM A

GRADE EIGHT

Items Correct	TEST 1 V & F	TEST 2 Comp.	TEST 3 Prob.
34			
33			
32	2		
31	3		
30	5	2	
29	9	1	
28	11	2	
27	11	6	
26	8	5	
25	14	3	1
24	8	8	2
23	10	10	4
22	6	12	3
21	2	12	10
20	4	8	10
19	1	7	14
18	2	4	11
17	1	7	8
16	1	7	8
15	1	1	7
14	1	0	5
13		2	5
12		2	4
11		0	0
10		0	2
9		0	3
8		1	0
7			1
6			1
5			0
4			1
3			
2			
1			
0			

No. of Pupils	100	100	100
Median	25.93	21.92	18.45
Possible Score	34	34	26

Table XVIII shows the grade attainment by total scores of Form A, revised. The possible score on the complete test is ninety-four.

TABLE XVIII - GRADE ATTAINMENT BY COMPOSITE SCORES OF FORM A, REVISED

FORM A						
ITEMS Correct	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	TOTAL
91-94						
86-90						
81-85					2	2
76-80				1	8	9
71-75				0	19	19
66-70				6	20	26
61-65				4	17	21
56-60				16	14	30
51-55			4	27	10	41
46-50			10	15	5	30
41-45		1	28	13	3	45
36-40		3	29	12	1	45
31-35		19	17	3	0	39
26-30	4	33	10	3	1	51
21-25	20	31	2			53
16-20	39	11				50
11-15	24	2				26
6-10	12	0				12
1- 5	1	0				1
No. of Pupils	100	100	100	100	100	500
MEDIAN	17.17	26.47	39.12	51.24	65.21	
Possible Score	94	94	94	94	94	

CHAPTER VIII.

EVALUATION OF THE DATA RESULTING FROM THE
FINAL ADMINISTRATION OF THE TEST.

Table XIX shows that in the Vocabulary and Fundamentals sub-test the median differences between the grade 4.4 and the grade 5.4 results is 3.85. The median difference between grade 5.4 and grade 6.4 groups is 3.75. Between grades 6.4 and 7.4 levels the difference is 3.78 while that between grades 7.4 and 8.4 results is 3.40. These differences are approximately the same.

TABLE XIX - MEDIAN SCORES AND MEDIAN SCORE DIFFERENCES OF THE VOCABULARY AND FUNDAMENTALS, COMPUTATION AND PROBLEM TESTS OF FORM A, REVISED.

Grade	Vocabulary and fund.		Computation		Problems	
	Median	Diff.	Median	Diff.	Med.	Diff.
FOUR (4.4)	11.15		4.35		3.41	
FIVE (5.4)	15.00	3.85	8.13	3.78	5.33	1.92
SIX (6.4)	18.75	3.75	13.19	5.06	8.85	3.52
SEVEN (7.4)	22.53	3.78	17.42	4.23	12.38	3.53
EIGHT (8.4)	25.93	3.40	21.92	4.50	18.45	6.07
Possible Score	34		34		26	

Results obtained in the Computation sub-test are a decided improvement over those received from the original test. The difference between the grade 4.4 and the grade 5.4 results is 3.78. Between grade 5.4 and grade 6.4 levels the difference is 5.06. This difference is the largest of any in this sub-test. Between the grades 6.4 and 7.4 levels and grades 7.4 and 8.4 results the differences are 4.23 and 4.50 respectively. These figures are evidence that the Computation sub-test now shows uniform increments in achievement at successive grade levels.

Of the three sub-tests the results from the Problem section are least satisfactory. The difference of 1.92 between the grade 4.4 and 5.4 levels is the least. The 3.52 difference between the grade 5.4 and 6.4 results approximates that of 3.53 between the grades 6.4 and 7.4 groups. Between the grade 7.4 and 8.4 results a difference of 6.07 is noted.

The graph of Figure 5 illustrates these facts. Note that since the revised test of Form A was given late in the fourth month of the school year the median results on this graph have been plotted at the fourth month levels. The revision for the Vocabulary and Fundamentals sub-test appears to be entirely satisfactory. An adjustment in the Computation sub-test might be made at the grade six level to lower the median results slightly. In the Problem sub-test it is evident that too many difficult problems have been retained at the grades five, six, and seven levels as the graph is depressed at these points.

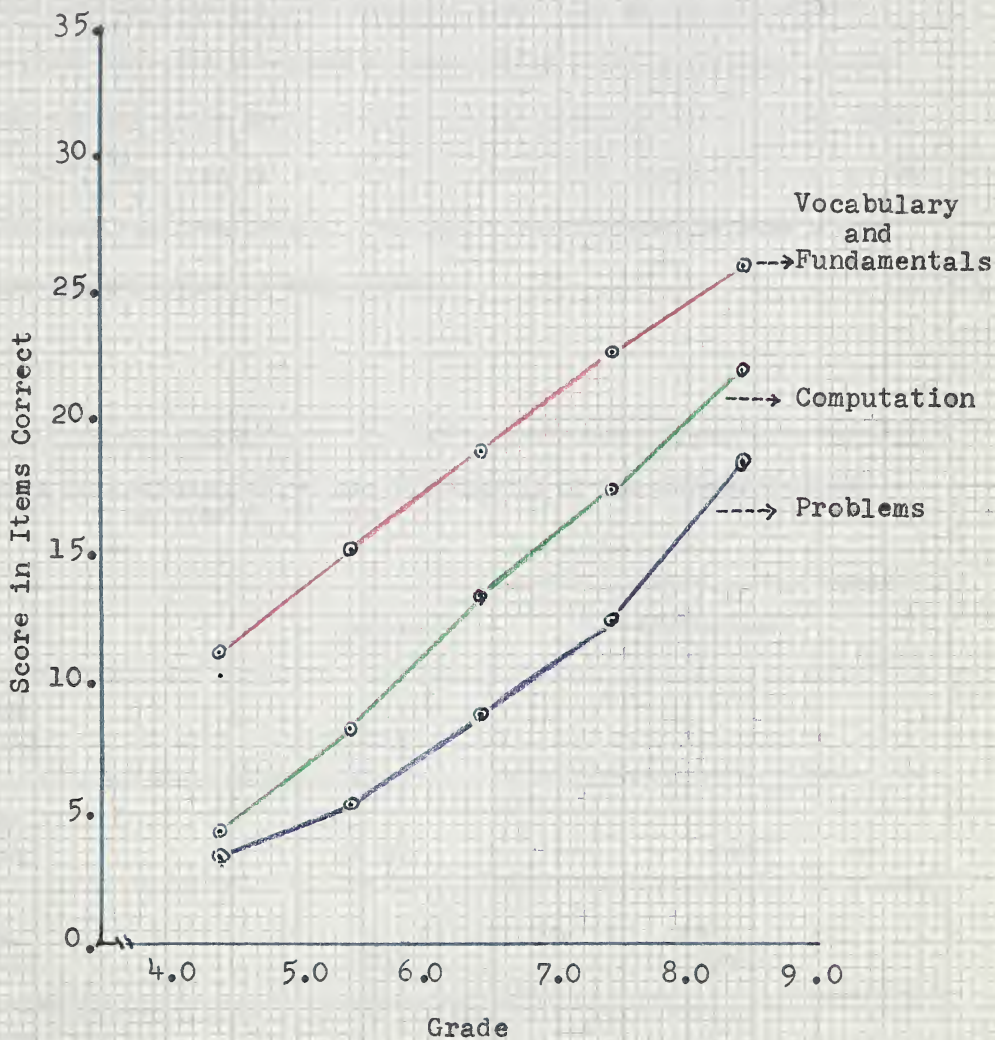
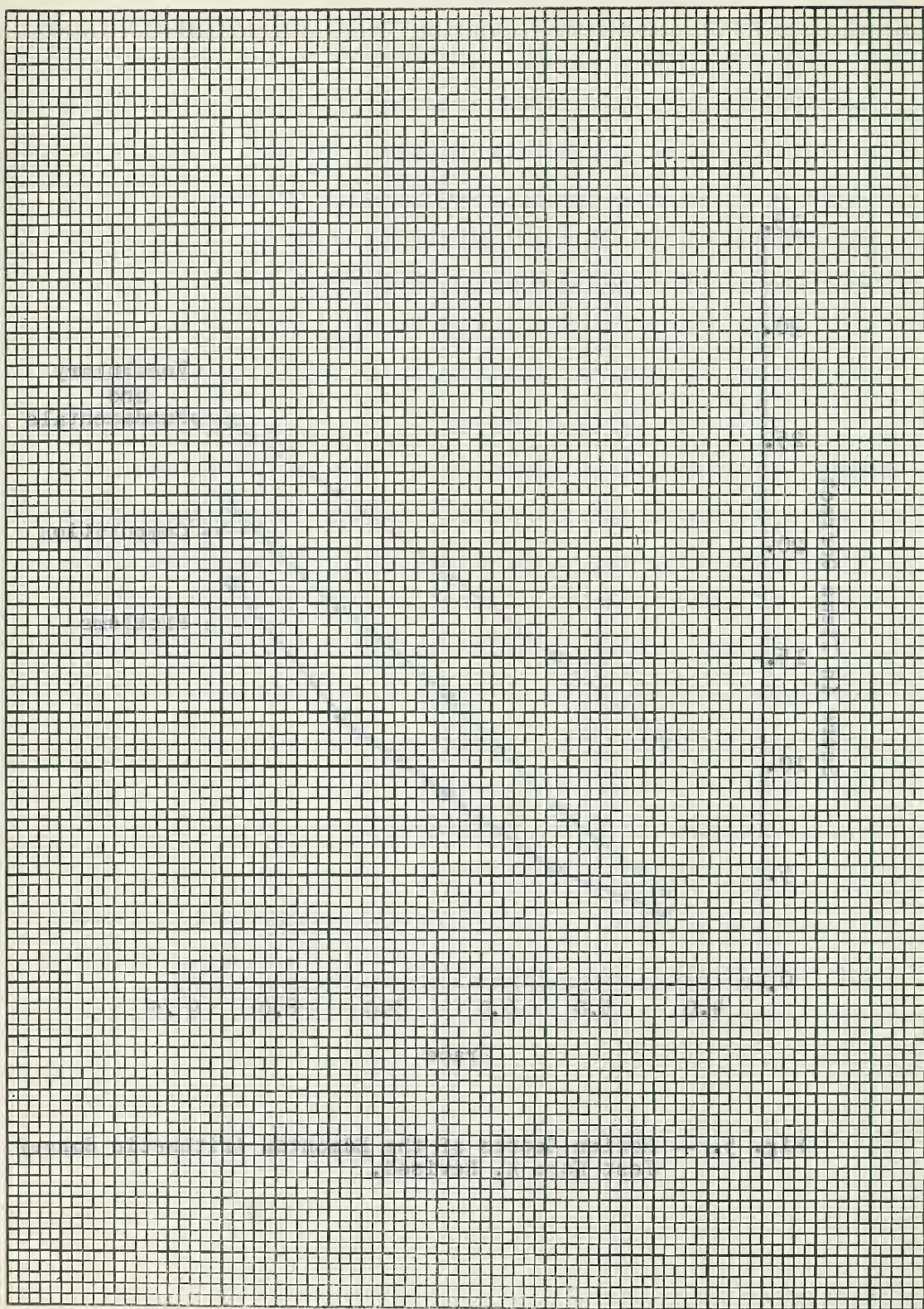


Fig. 5. -- Median Scores of the Edmonton Arithmetic Survey Test Form A, Revised.



From Table XX we observe that the differences between the medians of the total scores are relatively equal. Between the grade four and the grade five medians the difference is 9.30. The difference between the grade five and the grade six medians is 12.65 while that between grade six and grade seven is 12.12 and between grades seven and eight is 13.97. The greatest variation in these differences is shown at the grade four and five levels. The last three differences show a very close approximation to each other.

TABLE XX - MEDIAN AND MEDIAN DIFFERENCES OF THE COMPOSITE SCORES
OF FORM A, REVISED.

Grade	Median	Difference
FOUR (4.4)	17.17	
FIVE (5.4)	26.47	9.30
SIX (6.4)	39.12	12.65
SEVEN (7.4)	51.24	12.12
EIGHT (8.4)	65.21	13.97

This fact is borne out when the graph of Figure 6 is studied. It is evident that although the graph is depressed slightly at the grade five, six, and seven levels, there is a decided improvement in its linearity as compared with the graph of the medians of the total scores of the original test.

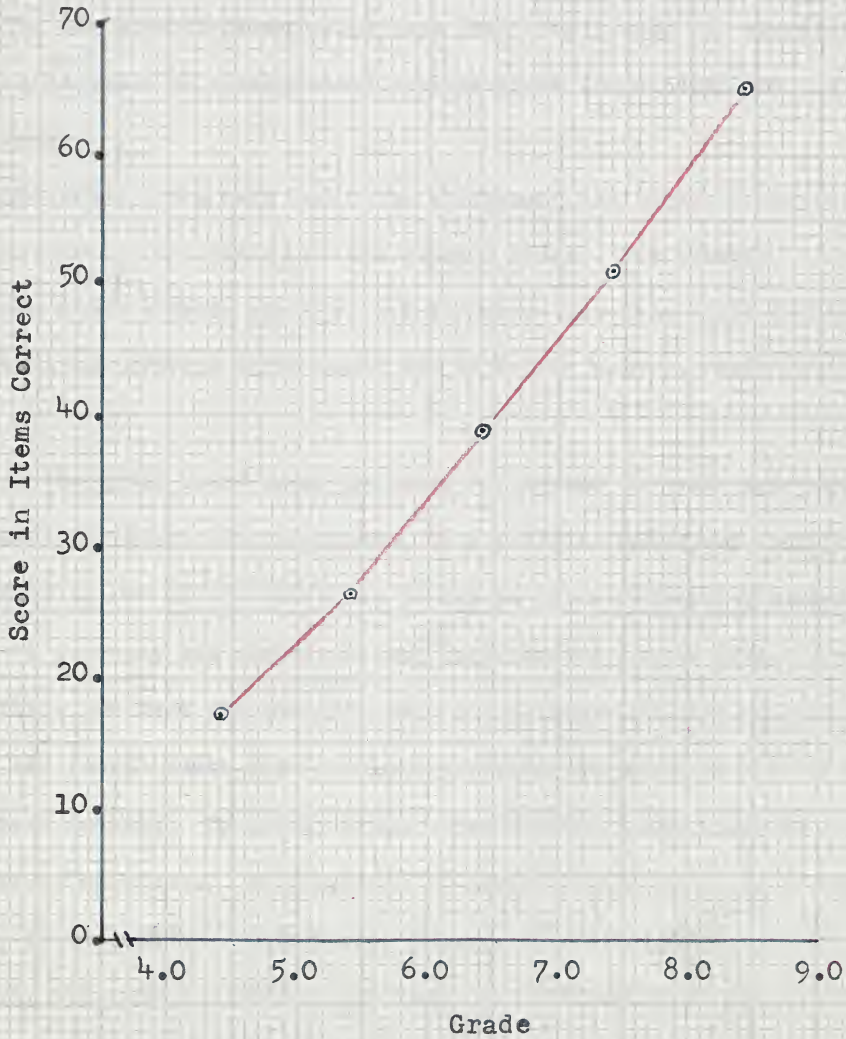
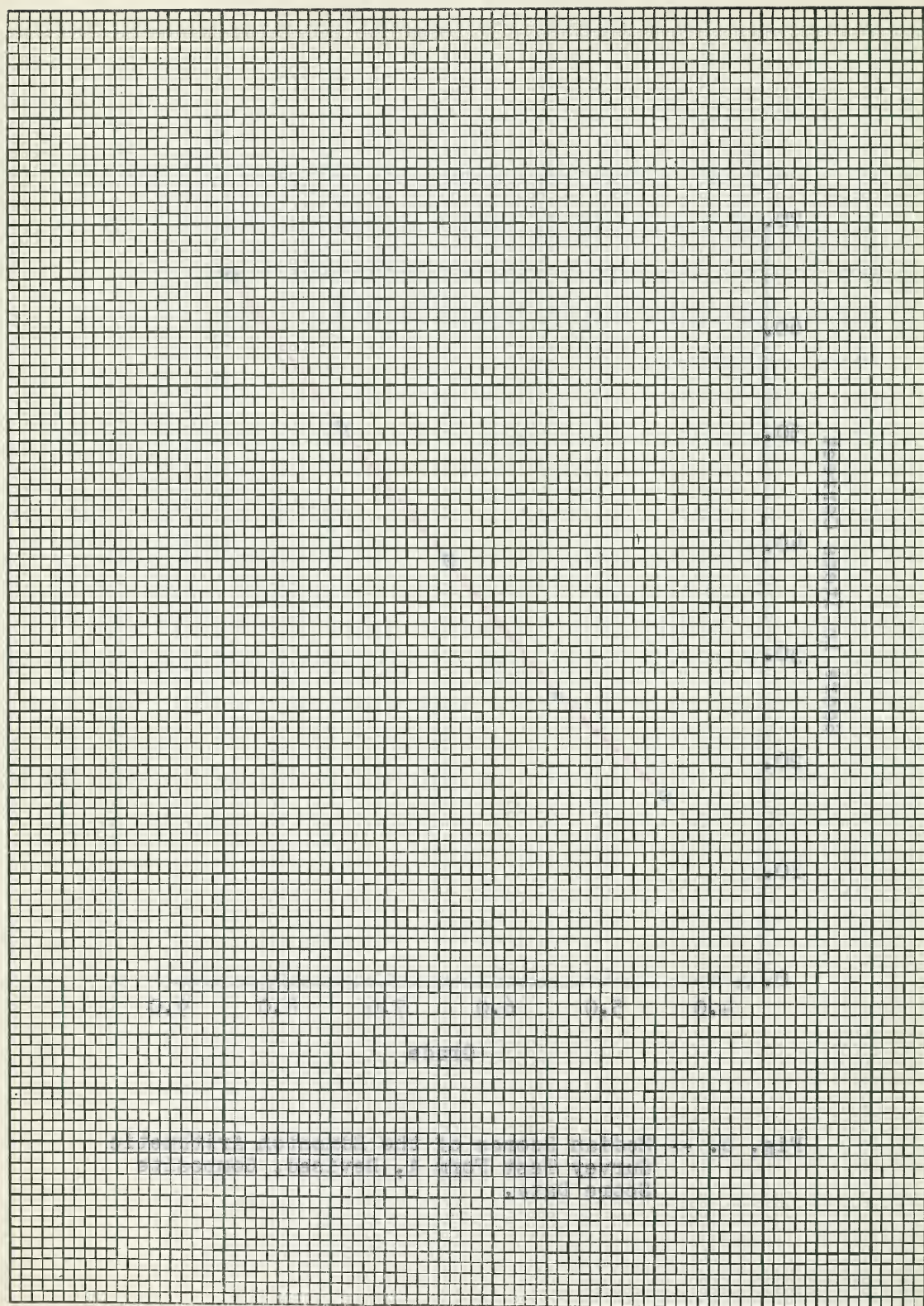


Fig. 6. -- Median Scores of the Edmonton Arithmetic Survey Test Form A, Revised, Composite Score Data.



CHAPTER IX

NORMS

1. GRADE SCORE NORMS

The two sets of norms which seem most widely used for expressing pupil achievement on survey tests are the grade score norms and the percentile norms.

The grade score norm indicates achievement in terms of the rate of progress through the grades of the average child. For example, if a pupil's raw score shows a grade score of 6.8 it means that this child obtained a score that the average child would get if he had been in grade six for eight months.

As the grade score norms may also be charted for each sub-test, they are useful for diagnostic purposes. If a child is below the average grade attainment in one of the sub-tests he may be given remedial treatment in an effort to overcome his weaknesses and deficiencies in the indicated area.

Since the test was administered to the sample of five hundred at the end of the fourth month five absolute positions at which to fix the grade norms were secured. To obtain grade norms between these absolute scores two methods were used. By a process of interpolation in terms of equal monthly increments the grade scores between the fixed points at the 4.4, 5.4, 6.4, 7.4, and 8.4 levels were computed. Through examination of the tendency of the data and employment of extrapolation the grade scores were extended to 3.0 and 9.0. Assuming linearity by a "best-fitting" line for the median scores of each sub-test and for the medians of the composite scores the grade norms were also obtained from a graph. The intervening scores between the 4.4 and 8.4 medians were read directly from the graph. Beyond these scores they were extrapolated to the 3.0 and 8.10 or 9.0

scores. No scores are shown beyond the 3.0 and 9.0 terminals. A score below the 3.0 level is meaningless in so far as this test is concerned because the work below that level is too elementary for our consideration. Past the 9.0 point the content continuum is broken due to the work in mathematics in grade nine being concerned chiefly with algebra and geometry.

Figure 7 and Figure 8 are the graphs showing the "best-fitting" lines for the median scores of the sub-tests and for the medians of the composite scores respectively.

Table XXI lists the raw scores and their grade score equivalents on the three sub-tests. Table XXII gives the composite raw scores with their grade score equivalents.

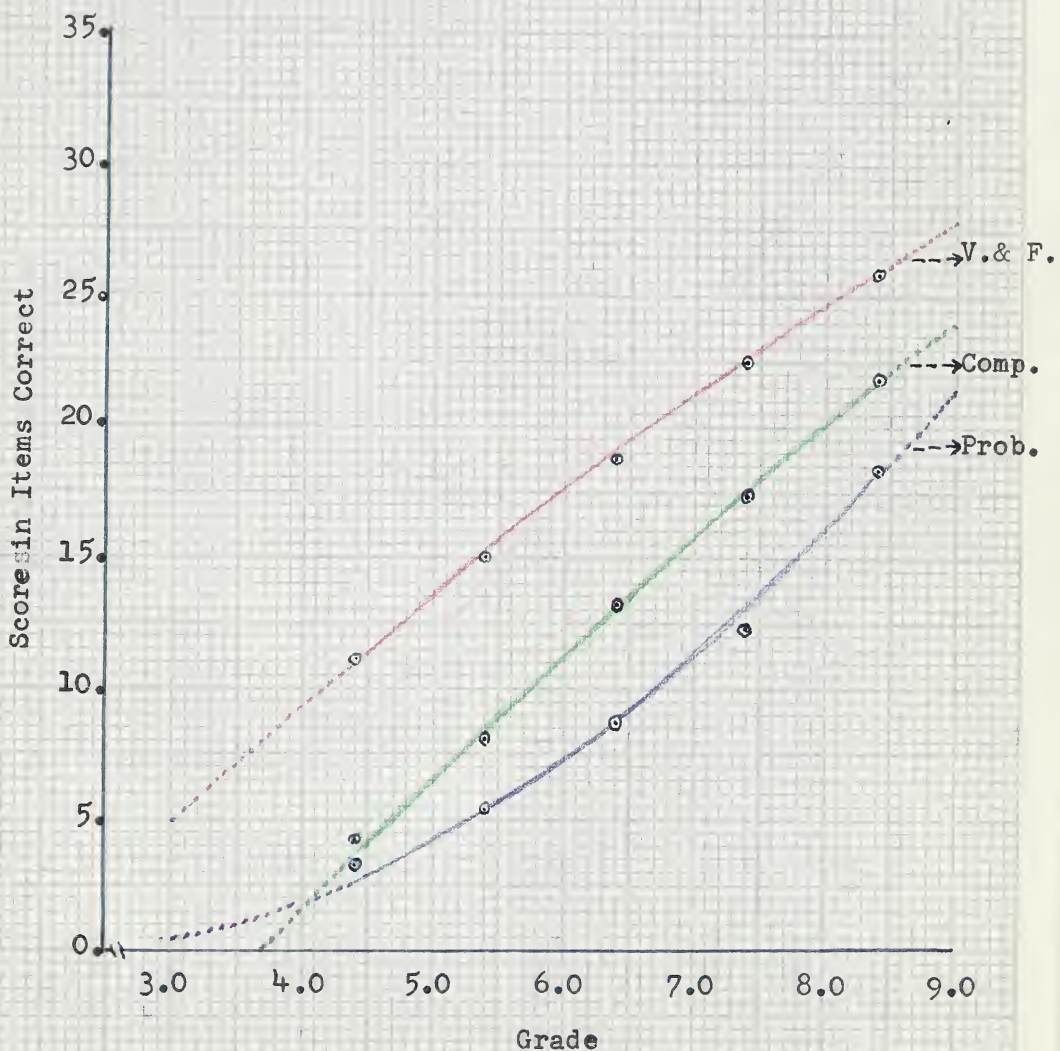
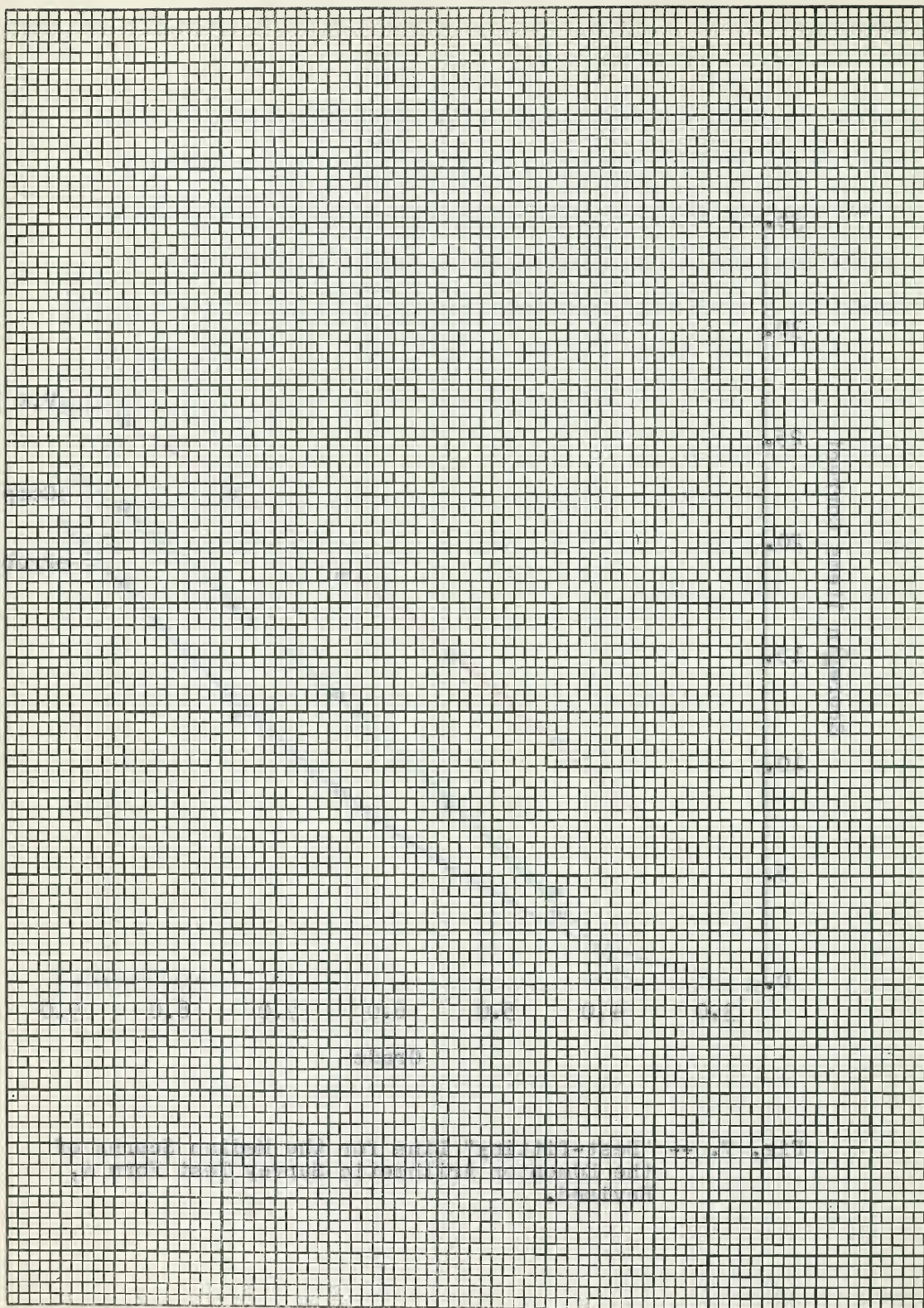


Fig. 7. -- "Best-fitting" Line for the Median Scores of the Edmonton Arithmetic Survey Test Form A, Revised.



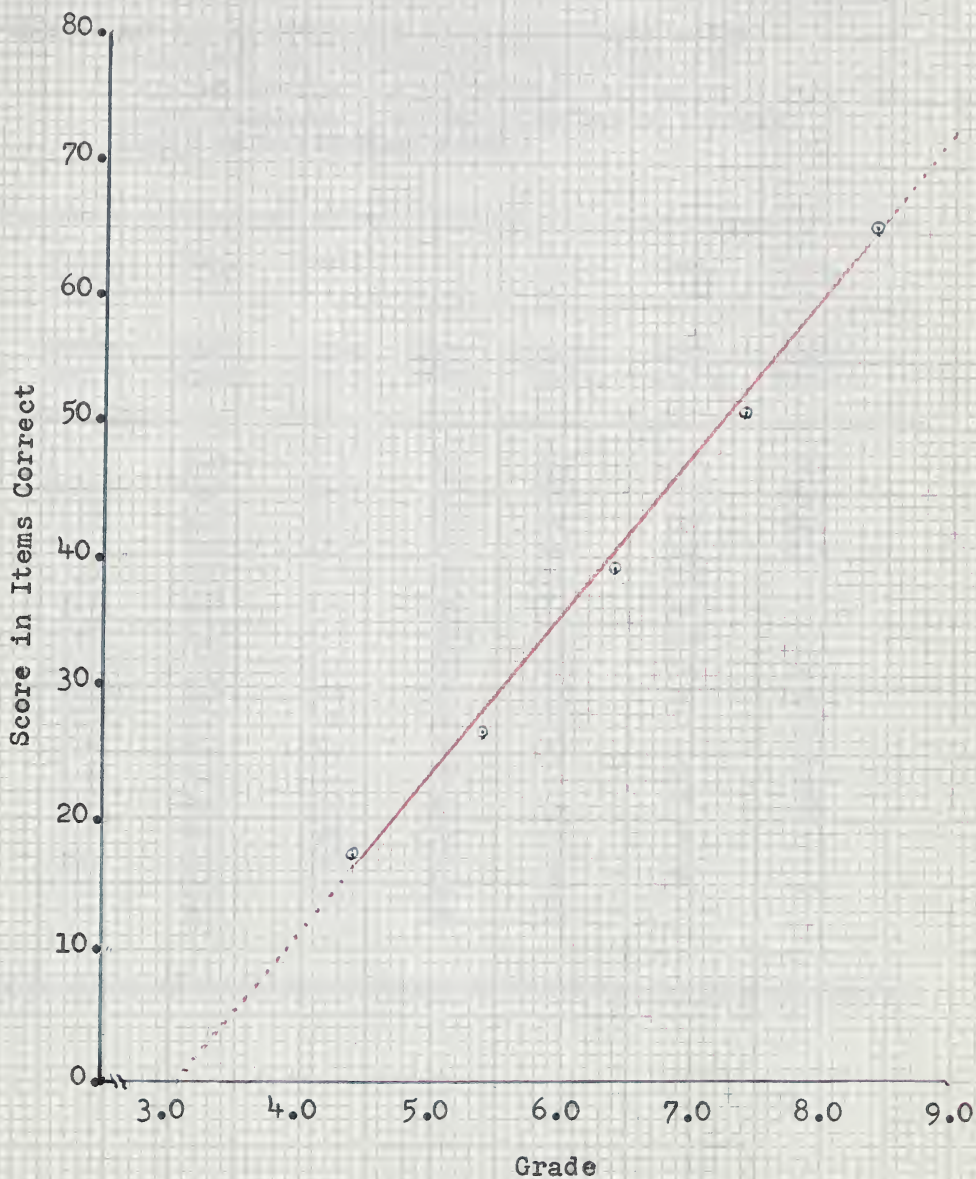


Fig. 8. -- "Best-fitting" Line for the Medians of the Composite Scores of the Edmonton Arithmetic Survey Test Form A, Revised.

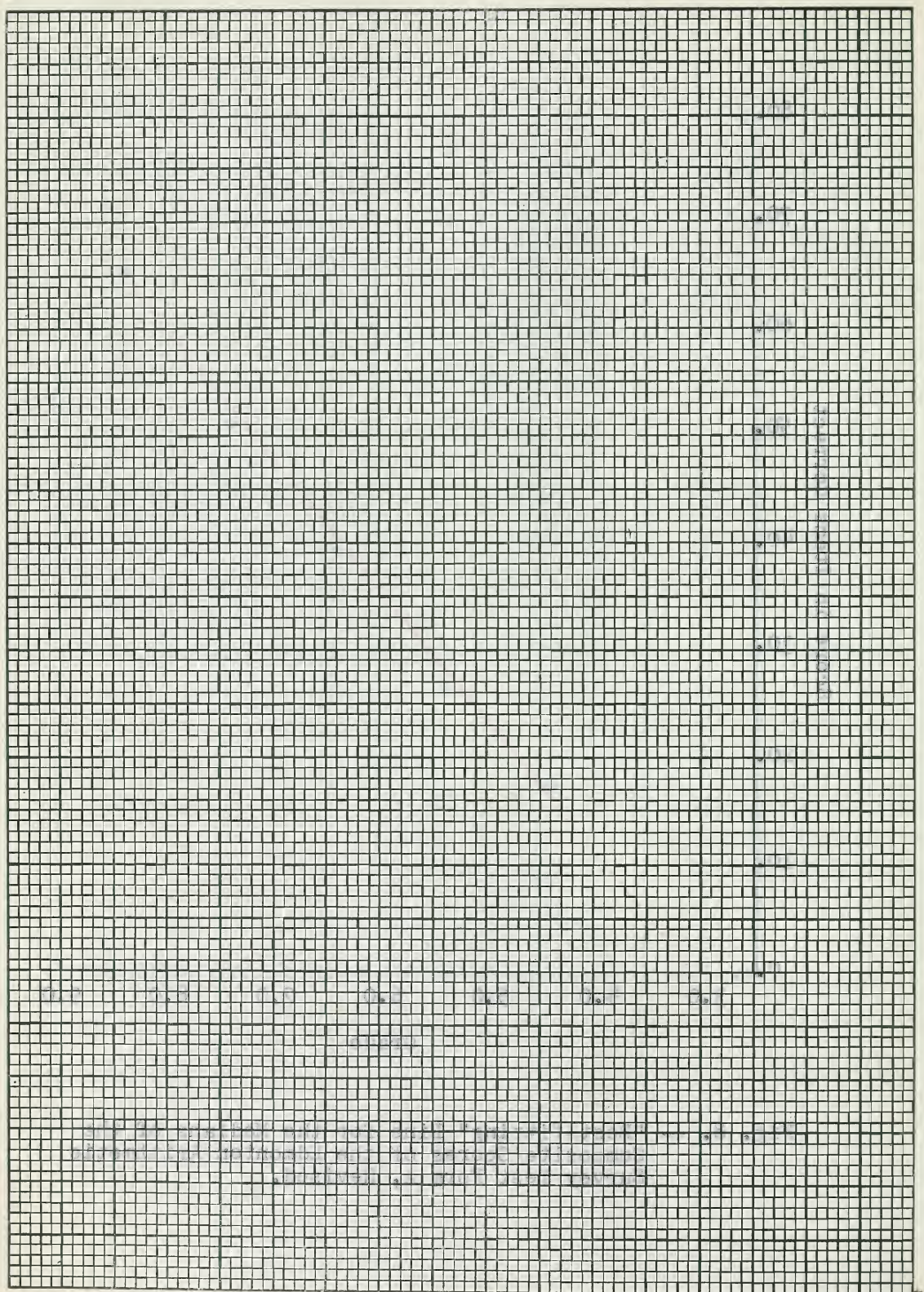


TABLE XXI. -- RAW SCORES WITH GRADE SCORE EQUIVALENTS ON THE VOCABULARY AND FUNDAMENTALS, COMPUTATION, AND PROBLEMS SUB-TESTS OF THE EDMONTON ARITHMETIC SURVEY TEST FORM A, REVISED, OBTAINED ON A RANDOM SAMPLE OF FIVE HUNDRED PUPILS.

V.&F.		Comp.	Prob.	V.&F.		Comp.	Prob.
Raw Score	Grade Equiv.	Grade Equiv.	Grade Equiv.	Raw Score	Grade Equiv.	Grade Equiv.	Grade Equiv.
1	-	3.8	3.3	18	6.1	7.5	8.3
2	Below	4.0	3.8	19	6.4	7.7	8.5
3	3.0	4.2	4.5	20	6.7	7.9	8.7
4	-	4.4	4.8	21	6.9	8.1	8.9
5	3.0	4.6	5.2	22	7.2	8.4	-
6	3.2	4.8	5.6	23	7.5	8.6	-
7	3.4	5.0	5.9	24	7.8	8.8	-
8	3.7	5.2	6.2	25	8.1	9.0	-
9	3.9	5.5	6.4	26	8.4	-	-
10	4.1	5.7	6.6	27	8.7	-	-
11	4.4	6.0	6.9	28	9.0	-	-
12	4.6	6.2	7.1	29	-	9.0	-
13	4.9	6.4	7.3	30	-	-	-
14	5.1	6.6	7.6	31	Above 9.0	-	-
15	5.4	6.8	7.8	32	-	-	-
16	5.6	7.1	8.0	33	-	-	-
17	5.9	7.3	8.1	34	Above 9.0	-	-

TABLE XXII. -- GRADE SCORE EQUIVALENTS FOR COMPOSITE
SCORES ON THE EDMONTON ARITHMETIC
SURVEY TEST FORM A, REVISED, BASED
ON A RANDOM SAMPLE OF FIVE HUNDRED
PUPILS.

Comp. Score	Grade Equiv.	Comp. Score	Grade Equiv.	Comp. Score	Grade Equiv.	Comp. Score	Grade Equiv.
1	3.1	24	5.1	50	7.2	73-74	-
2	3.2	25	5.2	51	7.3	75	-
3	3.3	26-27	5.3	52	7.4	76	-
4	3.4	28	5.4	53	7.5	77	-
5	3.5	29	5.5	54-55	7.6	78	-
6	3.6	30-31	5.6	56	7.7	79	-
7	3.7	32	5.7	57	7.8	80	-
8-9	3.8	33	5.8	58	7.9	81	-
10	3.9	34	5.9	59	8.0	82	-
11	4.0	35	6.0	60	8.1	83	-
12	4.1	36	6.1	61-62	8.2	84	-
13	4.2	37	6.2	63	8.3	85	-
14	4.3	38-39	6.3	64	8.4	86	-
15-16	4.4	40	6.4	65	8.5	87	-
17	4.5	41	6.5	66	8.6	88	-
18	4.6	42-43	6.6	67-68	8.7	89	-
19	4.7	44	6.7	69	8.8	90	-
20	4.8	45	6.8	70	8.9	91	-
21-22	4.9	46	6.9	71	9.0	92	-
23	5.0	47	7.0	72	-	93	-
		48-49	7.1		-	94	-

2. GRADE PERCENTILE NORMS

The percentile scores permit the teacher to determine a pupil's relative position with respect to the position of all other pupils in a particular grade. If, for example, a pupil makes a test score which exceeds precisely seventy-five per cent of the scores of his class, he is said to have a percentile rank of seventy-five in that test.

Percentile scores are also useful for dividing a class simply and easily into two, three or more groups for the express purpose of doing special or remedial work. If it were desired to divide the pupils into three groups, a convenient method would be to find the 33rd percentile score and the 67th percentile score. Into the lowest group would go all those whose scores were less than the 33rd percentile score, into the top group all those whose scores exceeded that of the 67th percentile score, and the remaining pupils would be left in the middle group.

Another use of percentile ranking of pupils is in the letter rating for report card purposes. If it is desired to give a five-letter rating, such as H, A, B, C, and D, to pupils on the basis of scores in a test, this may be done by giving those pupils who exceeded the 90th percentile score a letter rating of H, those whose score fall between the 70 and 90 percentiles a rating of A, those in the middle forty per cent with scores lying between the 30 and 70 percentile a rating of B, and so on as shown in Table XXIII which is based on current practice in the Edmonton Public School system.

TABLE XXIII. -- TABLE FOR ASSIGNING
LETTER RATING TO PUPILS
ON THE BASIS OF THE
PERCENTILE RANK OF
THEIR SCORES ON A TEST

Per Cent of Group	Percentile Rank	Rating
10%	90-100	H
20%	70-90	A
40%	30-70	B
20%	10-70	C
10%	0-10	D

As with the grade norms the percentile norms were based on the administration of the test to a sample of five hundred children in grades four to eight at the end of the fourth month. Teachers must be advised that percentile norms will indicate a lower standing if the test is administered earlier in the year, and will show a higher ranking if the test is administered later in the year. For this reason the grade score norms are perhaps more valuable for general use. It must be remembered that percentile norms are completely valid only for the time in the school year at which they were computed.

Table XXIV shows the percentiles by grades of the composite scores. These percentiles are based on one hundred pupils in each grade group.

TABLE XXIV. -- GRADE PERCENTILE NORMS OF
THE COMPOSITE SCORES OF
FORM A, REVISED, OBTAINED
FROM A RANDOM SAMPLE OF
ONE HUNDRED PUPILS PER
GRADE AND GIVEN AT THE
END OF THE FOURTH MONTH

Raw Scores					
%ile	Grade Four	Grade Five	Grade Six	Grade Seven	Grade Eight
5	6	16	26	33	44
10	9	18	29	36	49
15	10	20	31	40	52
20	11	21	33	42	54
25	13	22	34	43	56
30	14	23	35	45	58
35	15	24	36	46	60
40	16	25	37	48	61
45	16	26	38	49	63
50	17	27	39	51	64
55	18	28	40	52	66
60	19	28	41	53	68
65	20	29	42	54	69
70	21	30	44	56	71
75	22	31	45	58	73
80	23	32	46	59	75
85	24	34	48	61	77
90	26	36	49	64	80
95	28	38	52	68	85
99	32	43	58	75	93

In the manual of directions which accompanies the test there are tables showing the medians as well as the raw scores with their grade norms and percentile ranks. Instructions on how to administer and score the test are also included. The Manual and the test are found in the appendix.

CHAPTER X

THE RELIABILITY AND VALIDITY OF FORM A, REVISED.

The reliability of a test depends upon the consistency²¹ with which it measures what it is supposed to measure. A perfectly reliable test would give nearly the same results every time it was given. Although this ideal is often approached it is very seldom completely achieved not especially because the test falls short of perfection, but because of the variations in the pupils measured and the variations in the methods of test administration. A reliable test is comparatively free from chance errors of measurement, and scores obtained on it are relatively invariable and dependable. If a pupil makes a score of 65 on a reliable test we feel certain that this score shows very closely what his true ability is. If he made the same score on an unreliable test it would be neither invariable nor dependable because it would be subject to large errors of measurement. Subsequent testings of an unreliable test would produce results which would reveal many discrepancies between scores obtained by the same pupils on different occasions.

Four procedures are widely used for determining test reliability. These are the test re-test, the equivalent forms, the split-half, and the "rational equivalence" methods. Fairly dependable estimates of the reliability of test scores may be obtained by making use of any of these procedures.

The test re-test method is the simplest one for determining the reliability of scores since the test is given and then repeated on the same group of pupils. A correlation between the two sets of scores obtained is calculated and the reliability is thus established. As no re-test was given on the Revised Test, Form A, this method of checking its reliability was not possible.

The equivalent forms method involves computation of a correlation between parallel or alternate forms of a test. This procedure establishes a measure of the self-correlation of the test and can be used on tests for which

alternate forms are available. As Form B was not revised the use of this method for determining the reliability of Form A was impossible.

Although the split-half method is generally regarded as the best one for estimating test reliability²² it could not be used for this administration of the test. At the time of the testing no record was made which would give the proportion of the group answering each test item either correctly or incorrectly.

Since the Revised Test, Form A, is a composite of the original Form A together with items drawn from the supplementary test it was more practicable to employ the "rational equivalence" method for estimating reliability. This seems justified on theoretical grounds²³ as this method always tends to underestimate the reliability coefficient. For this estimation Froelich's²⁴ simple adaptation of the "rational equivalence" formula was used.

It reads:

$$r = \frac{n\sigma_t^2 - M(n-M)}{\sigma^2 (n-1)}$$

in which:

r = reliability of the whole test;

n = number of items in the test;

σ = standard deviation of the test scores;

M = the mean of the test scores.

Data were available which made it possible for substitutions to be made in the above formula. These data were:

$$n = 94 \text{ items.}$$

$$\sigma = 16.9$$

$$M = 40.81$$

The reliability coefficient of the whole test as determined by the above formula is .95. Even though this formula gives a satisfactory estimate of the test's reliability it underestimates to a slight degree that which would

be obtained if the split-half technique were used. This figure is to be considered as one of interim value only. In a later revision of the test it is hoped that the estimate of reliability will be computed by more searching methods.

VALIDITY

The validity of a test is defined "as that aspect of a test which insures that it will actually measure what it claims to measure."²⁵ Validity is an important function of a good test for unless a test is valid it serves no useful purpose. A test must be valid for the purpose for which it is to be used. The Edmonton Arithmetic Survey Test is designed to assist teachers in determining whether a child is strong or weak in the subject, to indicate broad areas of weakness in order that specific difficulties may later be located by diagnostic testing, and to concentrate the attention of the teacher on processes needing investigation.

Before discussing the validity of this test it is first advisable to make a distinction between logical or content validity and statistical validity. A test is said to possess high content validity when each item in it has been drawn from unquestionably important material in the subject field. A test is said to possess high statistical validity when it differentiates to a high degree between those who know more and those who know less. In other words, a valid test will arrange the students in order of their knowledge of the subject. The content validity of a test is determined by the selection of questions, but the statistical validity can be discovered only from the data obtained by trying out the test.

Long and Sandiford²⁶ offer the following suggestions for safeguarding the validity of a test.

1. The examination should be designed to measure a specific ability.
2. The examination should be based upon the curriculum which the teachers have been following. The curriculum is considered to be

a very fair common ground, for each teacher is supposed to have covered the course therein specified.

3. The examination should be based upon the text books the pupils are supposed to have studied.
4. The examination should be a fair sampling of the subject. The fairest example is one that covers the entire course. Objective tests are able to provide a more adequate sampling than that obtained by essay-type tests.
5. The examination should be limited to the more important aspects of the subject. This selection is not an easy one and some of the ways in which it is attempted are:
 - (a) a consensus of opinion from experienced teachers;
 - (b) a study of old examination papers on the subject will provide a list of important topics;
 - (c) topics should fit the main objectives of the course;
 - (d) important topics are those which have the greatest residual social values. Topics which prove their worth in the after-life of the individual are more important than those which are never used.
6. The examination questions should be worded in clear, simple English, ambiguity of statement and faulty sentence structure should be avoided.
7. The examination should be designed to encourage the pupil to do his best. The highest validity is secured by a steady performance on the part of the pupil. The steadiest performance is probably obtained when the pupil is working at his maximum capacity. Arrangement of the questions in order of increasing difficulty is perhaps the best method of securing the pupil's interest and effort.

The Revised Test, Form A, possesses high content validity for the purposes mentioned above as it parallels the teaching of arithmetic for the grades tested and is based upon the textbooks in current use in the Edmonton schools. The items of sub-tests are a fair sampling of the subject matter and are limited to the more important aspects of arithmetic. They are written in clear and simple English without ambiguity of statement or faulty sentence structure. To encourage maximum pupil interest the items are arranged in ascending order of difficulty. For class ratings well authenticated norms appropriate to the local situation are provided.

In order to understand the full significance of a test score it is necessary to know what performance the score predicts and how well it predicts that performance. This can be determined adequately only after an administration of the test and a statistical analysis of the results.

The usual method of obtaining the statistical validity of a test is by the comparison of its results with those of an acknowledged independent criterion. A criterion is an objective measure in terms of which the value of the test is estimated or judged. The comparison is made by finding the coefficient of correlation between the two series of marks obtained when the test results and the criterion results are secured from the same group of subjects. A high correlation between a test and a criterion is evidence of validity provided the test and the criterion are both reliable. But before accepting criterion correlations, we must know the reliability of the test and if possible the reliability of the criterion. Commonly used criteria against which to rate the test are school marks in the subject, average school marks, teachers' estimate of pupil ability and another established test.

The project of computing the statistical validity of the Revised Test, Form A, was not undertaken. No reliable criterion with which to judge the value of the test was immediately available. It is hoped that in a later revision of the test it may be validated against an acknowledged independent criterion.

CHAPTER XI

CONCLUSIONS AND RECOMMENDATIONS

I. Conclusions Concerning Forms A and B

1. The revised Form A of the Arithmetic Survey Test appears to be ready for use in the Edmonton School System. It has been demonstrated to test adequately the continuum of arithmetical knowledge in three major areas.

2. Plans should be made by the Director of Elementary Education for the organization of data resulting from the periodic use of the test with a view to continuing evaluation of its efficiency and in preparation for further revision.

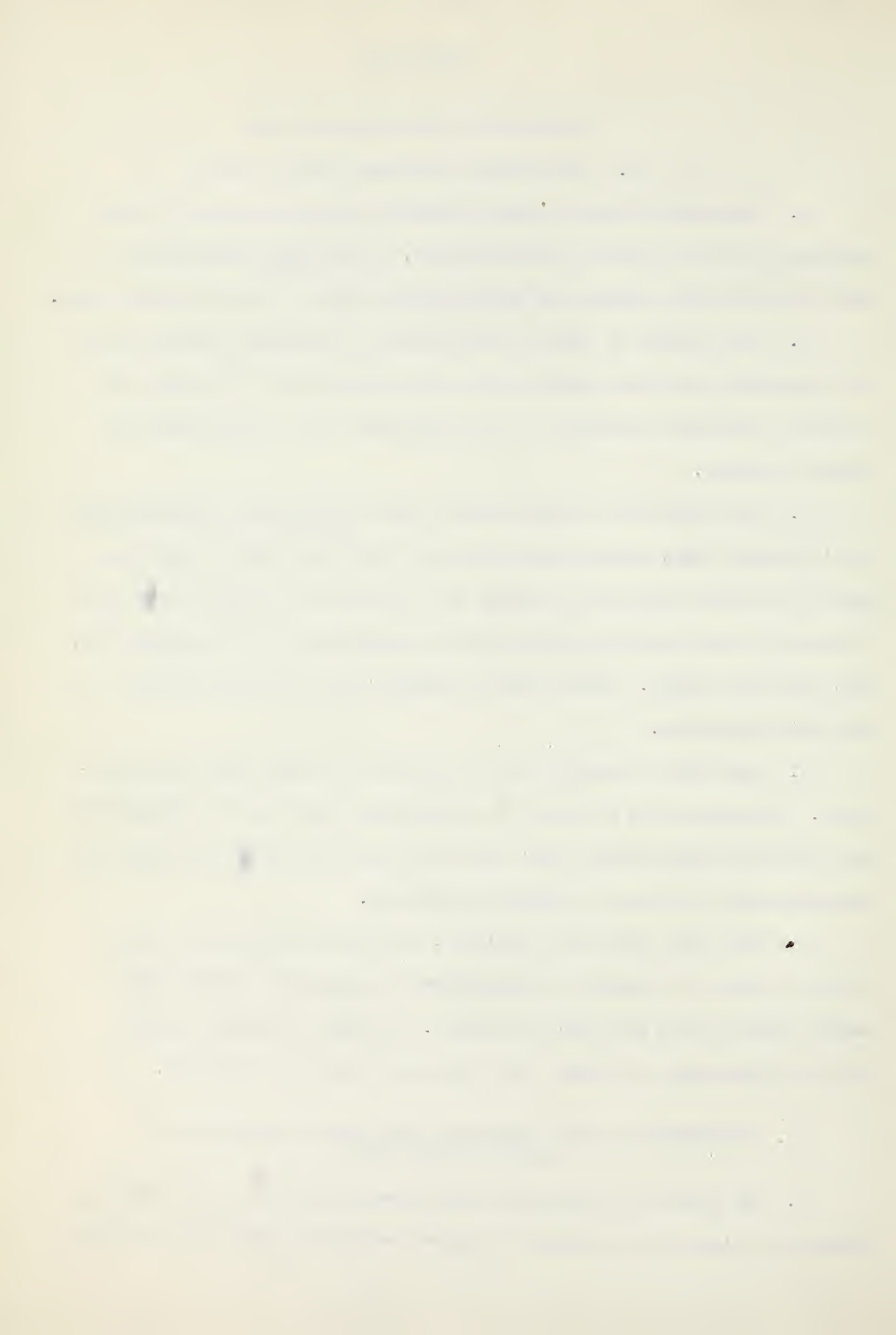
3. While the writer feels that the test will function satisfactorily in its present form, there is some basis for the belief that in the Computation sub-test the grade six level of difficulty is slightly lower than it should be and that the Problems test is somewhat hard at the grade five, six, and seven levels. These should be singled out for special study, as test data accumulate.

4. Since Form B was not revised it is not suitable for testing purposes. To prepare Form B for use a supplementary test must be administered to a properly chosen random sample and be of sufficient size to furnish an adequate number of items of suitable difficulty.

5. When Form B has been completed, following the procedure established in Form A, it should be administered to a properly chosen random sample selected from the grades concerned. It must be further revised until the forms are so equated that the same norms may be employed.

II. Recommendations for Committees Attempting Construction of Tests in Other Areas

1. The committee charged with the preparation of the test should be adequate in size and be composed of members possessing sound basic training



in statistics. In future ventures of this kind more effort should be made to distribute the responsibility in such a way that the directing committee will be free to concentrate upon problems of procedure.

2. The classroom teachers in the school system should be advised well in advance concerning the nature of the test, its value to the teaching staff, and the cooperation which is required from them.

3. The preliminary work of creating items should be given greater emphasis. It is highly desirable that the original pool of items should be approximately double the number required in the two final forms of the test. It will prove economical if those preparing items give greater thought to achieving a wider range of difficulty as items otherwise tend towards the mean. In the present study the author would have saved much time and work had the preliminary pool of items been adequate in number and quality.

BIBLIOGRAPHIC REFERENCES

1. Long, John A. and Sandiford, Peter. The Validation of Test Items. Department of Educational Research, University of Toronto, Toronto, 1935. p. 8.
2. Ibid., p. 10.
3. Ibid., p. 11.
4. Ibid.
5. Buros, Oscar Krisen. The Third Mental Measurements Yearbook. New Brunswick, N.J. Rutgers University Press, 1949. p. 421.
6. Buros, Oscar Krisen. The 1940 Mental Measurements Yearbook. Highland Park, New Jersey, 1941. p. 282.
7. Ibid.
8. Buros, The Third Mental Measurements Yearbook, p. 289.
9. Ibid.
10. Ibid.
11. Ibid., p. 420.
12. Ibid.
13. Ibid., p. 421.
14. Ibid.
15. Ibid., p. 422.
16. Buros, The 1940 Mental Measurements Yearbook, p. 295.
17. Ibid.
18. Garrett, Henry E. Statistics in Psychology and Education. Longmans, Green and Co., New York, 1947. p. 146.
19. Ibid., p. 142.
20. Ibid., p. 401.
21. Weitzman, Ellis and McNamara, Walter J. Constructing Classroom Examinations. Chicago, Science Research Associates, 1949. p. 3.
22. Garrett, op. cit., p. 383.
23. Ibid., p. 385.
24. Froelich, G. J. A Simple Index of Test Reliability. Journal of Educational Psychology, 32 (1941), pp. 381-385.
25. Long and Sandiford, op. cit., p. 7.

26. Ibid., p. 10.

A P P E N D I C E S

APPENDIX I

Manual of Directions

EDMONTON ARITHMETIC SURVEY TEST

(Revised)

Form A

Grades 4, 5, 6, 7, 8

Including Directions for
Giving and Scoring the Tests,
Medians, Grade Scores,
Percentile Norms and Keys.

Revision of 1951

EDMONTON PUBLIC SCHOOLS

MANUAL OF DIRECTIONS TO ACCOMPANY THE EDMONTON ARITHMETIC SURVEY TEST

Preparation of the Test.

Since 1949 a committee of Edmonton teachers, in cooperation with the administration, have been engaged in the preparation of an arithmetic survey test for use in the Edmonton Public Schools.

Revisions were made during the time when the test was used in mimeographed form. Medians, grade scores and percentile norms were calculated on the basis of results secured from a random sample of 100 pupils from each of the five grades for which it was designed. Printed forms of the test will be available henceforth to all teachers in grades four to eight.

Purpose of the Test.

The Edmonton Arithmetic Survey Test was carefully constructed to serve several purposes:

1. The test is designed to assist the teacher to determine whether a child is weak or strong in arithmetic.
2. The test is diagnostic in a broad sense only. If a weakness is indicated in one of the sub-tests specific difficulties may be located when a complete program of diagnostic testing is undertaken.
3. The test is useful in determining the need for preventive work. It may direct attention to the grade or area where a persistent general weakness in arithmetical processes occurs.
4. The test is standardized for the Edmonton Public School system. The teacher is thus able to tell where her class stands with reference to other classes in the city.
5. The test provides the pupils with a motive for better work.

Nature of the Test.

The items in each sub-test are arranged in ascending order of difficulty. By this arrangement each child is permitted to work up to his level of ability.

Test 1. Vocabulary and Fundamentals. This sub-test contains thirty-four questions. Many of them are of the multiple choice type.

Test 2. Computation. There are thirty-four questions in this sub-test which covers basic computational work for the grades concerned.

Test 3. Problems. The Problems sub-test has twenty-six items. As the emphasis is intended to be on thought processes the numbers used have been kept small purposely.

Reliability

The reliability of the Edmonton Arithmetic Survey Test was estimated by Froelich's simple adaptation of the "rational equivalence" formula. Although this formula underestimates the reliability as determined by the split-half technique it does give a satisfactory estimate. The reliability coefficient was calculated to be .95.

Validity

The Edmonton Arithmetic Survey Test possesses a high degree of content validity. The items it contains parallel the teaching of arithmetic for the grades tested and are a fair sampling of the subject-matter that is outlined for each. To encourage maximum pupil interest items found in each of the sub-tests are arranged in ascending order of difficulty. Well authenticated norms appropriate to the local situation are provided.

As no reliable criterion with which to judge the value of the test was immediately available no attempt was made to compute the statistical validity of the test. It is hoped that in a later revision of the test it may be validated against an acknowledged independent criterion.

Administration of the Test

I. When to Administer

The time for giving the test is left to the discretion of the teachers since circumstances vary considerably from class to class. If teachers wish to use the results along with other information for a mid-term report or classification, towards the end of the fourth month seems a good time to give the test. Diagnostic work may be done early in the term should the test reveal broad areas that are weak. If a general picture of achievement on the year's work is desired probably the best time to give the test would be toward the end of the ninth month when the year's work is completed.

II. How to Administer

A. Instruction to Teachers.

In general, observation of the ordinary precautions which apply to tests of this nature will be sufficient. The following special instructions should be noted:

1. Each sub-test requires about thirty to thirty-five minutes to complete. Arrangements should be made to give Test 1 at one sitting, Test 2 at another sitting on the following day, and Test 3 at a final sitting on the third day.
2. Since these tests are designed as 'power' tests no particular time limits have been set for them. Permit the class to work for a reasonable length of time or until 85% or more of the pupils have finished. Give NO help to the pupils once they begin the test.

3. Pupils are to write their answers directly on the test papers. Calculation and rough work should also be done on the test papers in the space provided but scratch pads should be available for those who need them.

B. Instructions to Pupils.

The teacher should read the following sets of instructions to the pupils just before they give each sub-test.

1. For Test 1. - Vocabulary and Fundamentals, say, "We are now going to have an arithmetic test. We want to see how well you know the meanings of words and principles in arithmetic. Many of the questions in this test are followed by four possible answers. Only one of these answers is correct. Put the answer you think is correct in the space at the right of the page. Do as many as you can. Work carefully but do not waste time."

2. For Test 2. - Computation, say, "In this arithmetic test we have some questions we want you to do. They are easy at first and gradually get harder. When I tell you to begin I want you to begin with the first question, go on to the next and so on until you can do no more. You are not timed but the test will stop when most of the class have finished. Reduce all fractions to their simplest form. Put your answers in the proper place at the right of the page."

3. For Test 3. - Problems, say, "We are now going to see how well we can solve problems in arithmetic. Read carefully each one before you attempt to find the answer. Then place your answer in the proper place at the right. Be sure to reduce all fractions to their simplest form. As the questions are arranged from very easy to very hard begin at the first question, go right on to the next and so on until you can do no more. Work quickly but carefully."

Directions for Scoring.

Scoring keys are provided in the manual.

1. No credit is deducted if dollar, cent or denominate number signs are omitted but decimal signs must be correctly placed. Fractions must be expressed in lowest terms, except in division questions.
2. Give one point credit for each answer in all sections of the test. The possible score for Test 1 is 34, for Test 2 is 34 and for Test 3 is 26. The total possible score is 94.
3. Pupils may help the teacher mark the papers from grade five up but the papers should be carefully checked to insure accuracy of results.
4. After the papers are marked the results should be entered in the spaces provided in the SCORE SUMMARY. The profile graph of GRADE EQUIVALENT should then be completed.

Interpretation of Results.

Results secured from a random sample of 100 pupils from each grade of four through eight of the Edmonton Public Schools were used to compile the tables of medians, grade norms and percentile norms appearing in the manual. These results were obtained toward the end of the fourth month.

1. Table of Medians. By consulting the table of median results for a particular grade the teacher is able to compare the achievement of her class with the achievement of the total population for her grade in each sub-section as well as in the composite scores.
2. Table of percentiles. The median results give the teacher an estimate of the "average" achievement of pupils in the system as a whole. The percentile tables provide additional information. From them the teacher can determine a pupil's relative position with respect to all other pupils for a particular grade.

Percentiles are not to be confused with percentages. A percentile ranking of 75 on a given test indicates that a pupil's score exceeds 75 per cent of the scores of all pupils taking that test. However this percentile rank of 75 does not mean that the pupils had 75% of the questions on the test correct. Such a rank, therefore, cannot be used as a percentage mark in the usual way.

3. Grading of pupils. Teachers may wish to use the results of these tests along with other evidence as a means of grading their pupils. In that connection, it is suggested that the following formula be used with the table of percentiles for each grade.

Per Cent of Group	Percentile Rank	Rating
10%	90-100	H
20%	70-90	A
40%	30-70	B
20%	10-30	C
10%	0-10	D

4. Table of Grade Norms. The table of grade norms was calculated on the data received when 100 pupils from each of the five grades took the test at the end of the fourth month.

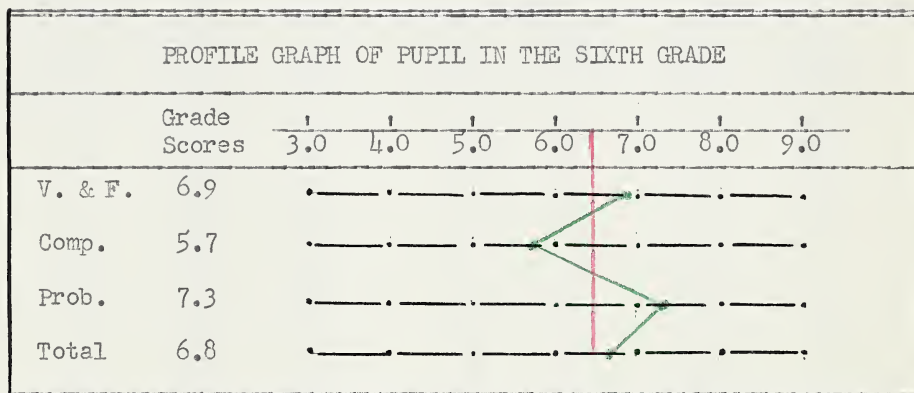
The grade score norm indicates achievement in terms of the rate of progress through the grades of the average child. For example, if a pupil's raw score shows a grade score of 6.8 it means that this child obtained a score that the average child would get if he had been in grade six for eight months. The grade norms help the teacher to locate broad areas of weakness. Specific difficulties of individual pupils may later be located by diagnostic testing.

5. How to Draw a Profile Graph.

After all information is recorded in the score summary, it can easily be interpreted by drawing a profile graph. A dot is placed on each of the horizontal lines at the point which indicates the particular grade score for each sub-test or for the total score. The position of these dots may be measured or estimated from the grade equivalent scale at the top of the chart. A vertical line is then

drawn to indicate the standard or norm against which the pupil's scores are to be interpreted. The usual standard would be the normal grade standard, representing the median of achievement of pupils at the same point in the grade in which the tested pupil is now enrolled. For example, if a pupil took the survey test upon entrance to the sixth grade, the vertical line would be drawn at 6.0 in the grade scale. If he took the test after having been in the grade five months, the vertical line would be drawn at a point halfway between 6.0 and 7.0.

The accompanying illustration shows a sample profile of a pupil in the sixth grade. The vertical line is drawn at 6.5 indicating that the pupil took the tests in the middle of the sixth grade.



MEDIAN OF THE SUB-TESTS AND OF THE COMPOSITE SCORES OF THE EDMONTON ARITHMETIC SURVEY TEST FORM A, REVISED, GIVEN TO A RANDOM SAMPLE OF ONE HUNDRED PUPILS IN EACH GRADE AT THE END OF THE FOURTH MONTH

TEST	POSSIBLE SCORE	Grade Four (4.4)	Grade Five (5.4)	Grade Six (6.4)	Grade Seven (7.4)	Grade Eight (8.4)
V. & F.	34	11.15	15.00	18.75	22.53	25.93
Comp.	34	4.35	8.13	13.19	17.42	21.92
Prob.	26	3.41	5.33	8.85	12.38	18.45
Composite	94	17.17	26.47	39.12	51.24	65.21

RAW SCORES WITH GRADE SCORE EQUIVALENTS
ON THE VOCABULARY AND FUNDAMENTALS, COM-
PUTATION AND PROBLEMS SUB-TESTS OF THE
EDMONTON ARITHMETIC SURVEY TEST FORM A,
REVISED, OBTAINED ON A RANDOM SAMPLE OF
FIVE HUNDRED PUPILS

V. & F. Comp. Prob.				V. & F. Comp. Prob.			
Raw Score	Grade Equiv.	Grade Equiv.	Grade Equiv.	Raw Score	Grade Equiv.	Grade Equiv.	Grade Equiv.
1	Below	3.8	3.3	18	6.1	7.5	8.3
2	3.0	4.0	3.8	19	6.4	7.7	8.5
3	-	4.2	4.5	20	6.7	7.9	8.7
4	-	4.4	4.8	21	6.9	8.1	8.9
5	3.0	4.6	5.2	22	7.2	8.4	-
6	3.2	4.8	5.6	23	7.5	8.6	-
7	3.4	5.0	5.9	24	7.8	8.8	-
8	3.7	5.2	6.2	25	8.1	9.0	-
9	3.9	5.5	6.4	26	8.4	■	■
10	4.1	5.7	6.6	27	8.7	■	■
11	4.4	6.0	6.9	28	9.0	■	■
12	4.6	6.2	7.1	29	:	■	■
13	4.9	6.4	7.3	30	:	■	■
14	5.1	6.6	7.6	31	9.0	9.0	9.0
15	5.4	6.8	7.8	32			
16	5.6	7.1	8.0	33			
17	5.9	7.3	8.1	34	Above	Above	Above

GRADE SCORE EQUIVALENTS FOR COMPOSITE SCORES ON THE
EDMONTON ARITHMETIC SURVEY TEST FORM A, REVISED,
BASED ON A RANDOM SAMPLE OF FIVE HUNDRED PUPILS.

Comp. Score	Grade Equiv.	Comp. Score	Grade Equiv.	Comp. Score	Grade Equiv.	Comp. Score	Grade Equiv.
1	3.1	24	5.1	50	7.2	73-74	...
2	3.2	25	5.2	51	7.3	75	...
3	3.3	26-27	5.3	52	7.4	76	...
4	3.4	28	5.4	53	7.5	77	...
5	3.5	29	5.5	54-55	7.6	78	...
6	3.6	30-31	5.6	56	7.7	79	...
7	3.7	32	5.7	57	7.8	80	...
8-9	3.8	33	5.8	58	7.9	81	...
10	3.9	34	5.9	59	8.0	82	...
11	4.0	35	6.0	60	8.1	83	...
12	4.1	36	6.1	61-62	8.2	84	...
13	4.2	37	6.2	63	8.3	85	...
14	4.3	38-39	6.3	64	8.4	86	...
15-16	4.4	40	6.4	65	8.5	87	...
17	4.5	41	6.5	66	8.6	88	...
18	4.6	42-43	6.6	67-68	8.7	89	...
19	4.7	44	6.7	69	8.8	90	...
20	4.8	45	6.8	70	8.9	91	...
21-22	4.9	46	6.9	71	9.0	92	...
23	5.0	47	7.0	72	-	93	...
		48-49	7.1		-	94	...

Above 9.0

GRADE PERCENTILE NORMS OF THE COMPOSITE SCORES OF FORM
A, REVISED, OBTAINED FROM A RANDOM SAMPLE OF ONE HUNDRED
PUPILS PER GRADE AND GIVEN AT THE END OF THE FOURTH MONTH

Raw Scores					
Percentile	Grade Four	Grade Five	Grade Six	Grade Seven	Grade Eight
5	6	16	26	33	44
10	9	18	29	36	49
15	10	20	31	40	52
20	11	21	33	42	54
25	13	22	34	43	56
30	14	23	35	45	58
35	15	24	36	46	60
40	16	25	37	48	61
45	16	26	38	49	63
50	17	27	39	51	64
55	18	28	40	52	66
60	19	28	41	53	68
65	20	29	42	54	69
70	21	30	44	56	71
75	22	31	45	58	73
80	23	32	46	59	75
85	24	34	48	61	77
90	26	36	49	64	80
95	28	38	52	68	85
99	32	43	58	75	93

SCORING KEY

Test 1	Test 2	Test 3
<u>Vocabulary and Fundamentals</u>	<u>Computation</u>	<u>Problems</u>
(1) \$60.60	(1) 2297	(1) \$8.54
(2) 18100	(2) $840 \frac{2}{6}$ or	(2) 19¢ or \$.19
(3) \$3.04	$840 \frac{1}{3}$ or	or \$.19
(4) 96186	840-2	(3) 50
(5) 3007	(3) 433018	(4) \$2.40
(6) 66002	(4) 82614	(5) \$3.99
(7) (1) or cent	(5) 27262	(6) 10
(8) (2) or mile	(6) 2652	(7) 8
(9) (3) or ton	(7) \$22.36	(8) \$180
(10) $\frac{1}{2}$	(8) 499513	(9) $1 \frac{3}{8}$
(11) $\frac{5}{5}$	(9) 30-4 or	(10) 146 lb.
(12) 3	30 $\frac{4}{69}$	(11) 1000
(13) 6	(10) 147500360	(12) 25%
(14) (2) or 6 gal.	(11) $15 \frac{23}{24}$	(13) 70¢
(15) (3) or $\frac{4}{5}$	(12) $\frac{3}{10}$	(14) 80°
(16) (2) or the	(13) $1 \frac{2}{5}$	(15) 10
perimeter	(14) $1 \frac{5}{8}$	(16) 400
(17) (2) or three	(15) $6 \frac{13}{24}$	(17) \$9.60
(18) (4) or per	(16) $37 \frac{1}{12}$	(18) 3600 lb.
hundred	(17) 17450	(19) \$40
(19) (4) or 10	(18) $\frac{1}{4}$	(20) 88 inches
(20) (3) or 90% of	(19) .68120 or	(21) \$ 15360
the marked	0.68120 or	(22) 70 degrees
price	016812 or	(23) 42¢
(21) (b)	.6812	(24) \$ 280
(22) (2) or divid-	(20) 16	(25) \$ 180
ed into two	(21) $\frac{7}{20}$	(26) \$ 459
equal parts	(22) .175	
(23) (4)	(23) 6.2	
(24) (1) or larger	(24) \$ 26.40	
(25) (4) or pi	(25) $\frac{17}{20}$	
(26) 4	(26) 6	
(27) 25 or 25%	(27) 4	
(28) 3000	(28) 41.5% or $41\frac{1}{2}\%$	
(29) (3) or $\frac{7}{22}$	(29) \$ 187.50	
(30) (2) or	(30) \$ 9.88	
principal	(31) 23	
(31) 3	(32) 216 sq. ft.	
(32) 45 degrees	(33) $6 \frac{2}{5}$ or 6.4	
(33) AC	(34) 616 sq. ft.	
(34) 1		

APPENDIX II

EDMONTON ARITHMETIC SURVEY TEST

(Revised)

Vocabulary and Fundamentals, Computation and Problems.

Name Boy or Girl

Age (years) Date of next birthday
Month, day, year

Grade Teacher

Date

SCORE SUMMARY						
TEST	Subject	Possible Score	Pupil Score	Grade Equiv.	Percentile Rank	RATING
1.	V. & F.	34			-	-
2.	Comp.	34			-	-
3.	Prob.	26			-	-
	TOTAL	94				

PROFILE GRAPH OF GRADE EQUIVALENTS								
	Grade Scores	3.0	4.0	5.0	6.0	7.0	8.0	9.0
V. & F.		.	—	.	—	.	—	.
Comp.		.	—	.	—	.	—	.
Prob.		.	—	.	—	.	—	.
TOTAL		.	—	.	—	.	—	.

EDMONTON ARITHMETIC SURVEY TEST

FORM A

(Revised)

Grades Four Through Eight

Test 1 - VOCABULARY AND FUNDAMENTALS

Directions to Pupils: This is a test to see how well you know the meanings of words and principles in Arithmetic. You are to do as many questions as you can. Work carefully but do not waste time. Put your answers in the space provided at the right.

Write down the largest number in each row in the proper space at the right.

(1)	\$60.06	\$60.60	\$60.00	\$6.06	(1)	ANSWER _____
(2)	3275	602	18005	18100	(2)	_____

Write each of these numbers in figures. Put your answer in the space at the right.

(3)	Three dollars and four cents	(3)	_____
(4)	Ninety-six thousand one hundred eighty-six	(4)	_____
(5)	Three thousand seven	(5)	_____
(6)	Sixty-six thousand two	(6)	_____

In the question below decide which statement is correct. Then place its number in the space at right.

(7)	¢ means (1) cent, (2) quarter, (3) dime,	(7)	_____
	(4) dollar		
(8)	mi. means (1) foot, (2) mile, (3) part,	(8)	_____
	(4) minute		
(9)	T. means (1) times, (2) yards, (3) ton,	(9)	_____
	(4) quart		

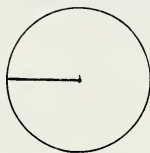
Write down the largest fraction in each row in the proper space at the right.

(10)	$\frac{1}{4}$	$\frac{1}{6}$	$\frac{1}{3}$	$\frac{1}{2}$	(10)	_____
(11)	$\frac{4}{8}$	$\frac{1}{8}$	$\frac{5}{5}$	$\frac{1}{2}$	(11)	_____

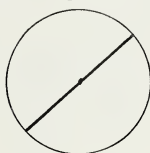
Work the following exercises. Put your answer in the proper space at the right.

(12)	The divisor is 2 and the dividend is 6. What is the quotient?	(12)	_____
(13)	The product of two numbers is 24. The multiplier is 4. What is the multiplicand?	(13)	_____
(14)	24 qt. is the same as:		
	(1) 6 pt. (2) 6 gal. (3) 6 pk. (4) 6 bu.	(14)	_____

- (15) If $\frac{8}{10}$ is changed to its simplest form, the answer is: ANSWER
 (1) 80 (2) $8\frac{1}{10}$ (3) $\frac{4}{5}$ (4) $1\frac{1}{4}$ (15) _____
- (16) To buy fencing for a garden which do you need to know, (1) the area, (2) the perimeter, (3) the diameter, (4) the circumference? (16) _____
- (17) When 18,469 is divided by 23 there is no remainder; it goes evenly. Without doing the dividing in 23)18469 tell how many figures there should be in the answer. (17) _____
- (18) Per cent means (1) per dozen, (2) per thousand, (3) per score, (4) per hundred. (18) _____
- (19) How many $\frac{1}{6}$'s are there in $\frac{5}{3}$?
 (1) 5, (2) 6, (3) $\frac{1}{5}$, (4) 10. (19) _____
- (20) When 10% discount is given on an article purchased, you pay:
 (1) less than the marked price;
 (2) more than the marked price;
 (3) 90% out of the marked price;
 (4) about the same as the marked price. (20) _____
- (21) Which of these figures shows a diameter?



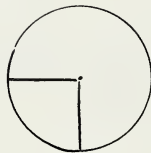
(a)



(b)



(c)



(d)

(21) _____

- (22) When a straight line is bisected it is:
 (1) divided into three equal parts;
 (2) divided into two equal parts;
 (3) increased in length by one-half;
 (4) increased by its own length (22) _____
- (23) In which figure below is there a right angle?



(1)



(2)



(3)

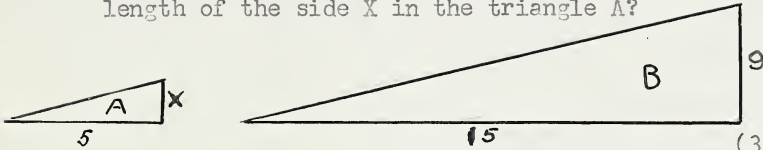


(4)

(23) _____

- (24) When $9\frac{1}{2}$ is divided by 15 the result will be:
 (1) larger, (2) smaller, than $4\frac{1}{2}$. (24) _____
- (25) When the circumference of a circle is divided by its diameter, the result will be represented by:
 (1) $\frac{7}{22}$, (2) $3\frac{1}{2}$, (3) $4\frac{4}{7}$, (4) pi. (25) _____
- (26) When two lines intersect how many angles are formed? (26) _____

- (27) What per cent of 8 is 2? (27) _____
- (28) 150 is 5% of what larger number? (28) _____
- (29) In any circle $\frac{\text{diameter}}{\text{circumference}}$ would be represented by: (1) pi, (2) 3.1416, (3) $7/22$ (29) _____
- (30) The sum of money borrowed from a bank is called: (1) amount, (2) principal, (3) interest, (4) proceeds. (30) _____
- (31) A and B are similar triangles. What is the length of the side X in the triangle A?

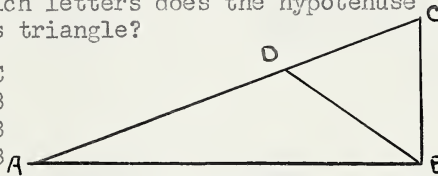


(31) _____

- (32) What is the angle of elevation of the sun when a boy 5'6" tall throws a shadow of 5'6" in length? (32) _____

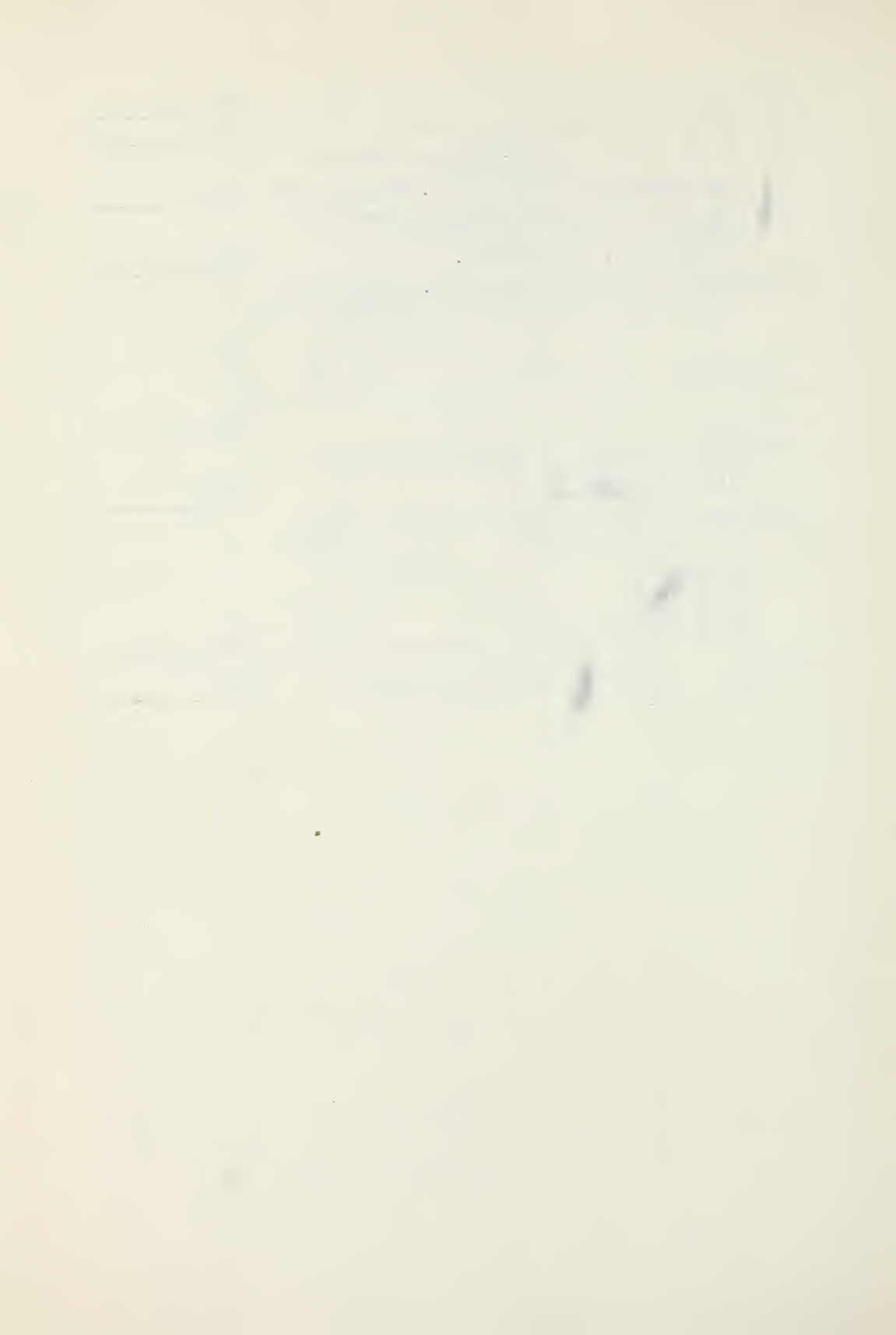
- (33) Between which letters does the hypotenuse lie in this triangle?

- (a) A and C
(b) D and B
(c) A and B
(d) C and B



(33) _____

- (34) $\frac{1}{4X}$ is equal to $\frac{1}{4}$. What is X equal to? (34) _____



EDMONTON ARITHMETIC SURVEY TEST

FORM A

(Revised)

Grades Four Through Eight

Test 2 - COMPUTATION

Directions to Pupils: Do each example as you come to it. Look carefully at each example to see what you are to do. As soon as you have finished an example, write the answer on the line provided at the right. Be sure to put your answer on the line that has the same number as the number of the example.

			ANSWER
(1) Add	(2) Divide	(3) Subtract	(1) _____
609		710055	(2) _____
523	6)5042	277037	(3) _____
718			
<u>447</u>			
(4) Subtract	(5) Multiply	(6) Add	(4) _____
90652	634	285	(5) _____
<u>8038</u>	<u>43</u>	438	(6) _____
		809	
		298	
		470	
		<u>352</u>	
(7) Add	(8) Multiply	(9) Divide	(7) _____
\$.63	71359	69)2074	(8) _____
9.90	<u>7</u>		(9) _____
4.64			
.62			
<u>6.57</u>			
(10) Multiply	(11) Add	(12) Subtract	(10) _____
20804	5 3/4	7/10	(11) _____
<u>7090</u>	6 3/8	<u>2/5</u>	(12) _____
	<u>3 5/6</u>		
(13) Add	(14) Add	(15) Subtract	(13) _____
4/5	3/4	15 1/6	(14) _____
<u>3/5</u>	<u>7/8</u>	<u>8 5/8</u>	(15) _____
(16) Multiply	(17) Divide	(18) Divide	(16) _____
5 x 7 5/12	.04)698	3 1/3 ÷ 13 1/3	(17) _____
			(18) _____

ANSWERS

- (19) Multiply $\begin{array}{r} 13.624 \\ \times .05 \\ \hline \end{array}$ (20) $\frac{Y}{2} = 8$ (19) _____
Y = (20) _____
- (21) Change .35 to a common fraction (21) _____
(22) Change $7/40$ to decimal form (22) _____
(23) What is the square root of 38.44? (23) _____
(24) What is 120% of \$22.00? (24) _____
(25) Express 85% as a common fraction (25) _____
(26) Solve for X: $4x - 7 = 17$ (26) _____
(27) Solve for X: $7x + 5 = 33$ (27) _____
(28) Express .415 as a percent (28) _____
(29) Find the interest on \$1250 for $2\frac{1}{2}$ years at 6% (29) _____
(30) What is 8% of \$123.50? (30) _____
(31) What is the square root of 529? (31) _____
(32) The base of a triangle is 24 feet and its height is 18 feet. Find its area (32) _____
(33) Solve for X: $\frac{x}{8} = \frac{4}{5}$ (33) _____
(34) Find the area of a circle whose radius is 14 feet. (Take $\pi = 3 \frac{1}{7}$) (34) _____

EDMONTON ARITHMETIC SURVEY TEST

FORM A

(Revised)

Grades Four Through Eight

Test 3 - Arithmetic Problems

Directions to Pupils: This is a test to see how well you can do arithmetic problems. You are to do as many questions as you can. Work carefully but do not waste time. Put your answers in the space provided at the right.

ANSWERS

- (1) Mr. Brown spent \$1.79 for a pair of gloves. He then had \$6.75 left. How much money did he have before he bought the gloves? (1) _____
- (2) Ann's father paid \$1.33 for 7 gallons of gasoline. How much was the price of one gallon? (2) _____
- (3) Ralph is exactly 4 feet 2 inches tall. How many inches tall is Ralph? (3) _____
- (4) Betty saved \$1.20 for the Red Cross. Fred saved twice as much as Betty. How much did Fred save? (4) _____
- (5) Ann's mother gave her \$15.00 to pay for camp clothes. She bought a pair of running shoes for \$1.25, a pair of shorts for \$1.79, a blouse for \$1.38 and a jacket for \$6.59. How much money did Ann have left? (5) _____
- (6) Larry bought some work-books at 2 for 15¢. How many workbooks could he get for 75¢? (6) _____
- (7) At the rate of 24 lbs. for 75¢, how many pounds of onions could Mary's mother buy for 25¢? (7) _____
- (8) Spitfire airplanes use 9¢ worth of gasoline to fly a mile. How much will the gasoline cost if 10 Spitfires travel the 200 miles from Calgary to Edmonton? (8) _____
- (9) Helen bought 2 $\frac{3}{4}$ lb. of chocolate, $\frac{7}{8}$ lb. of fudge and 1 lb. of toffee. She used 3 $\frac{1}{4}$ lb. of the candy to fill a box to send to a friend in the hospital. How many lbs. of candy did she have left? (9) _____
- (10) The weights of the five boys on a basketball team were 127.2 lb., 134.3 lb., 161.1 lb., 152.8 lb., and 154.6 lb. What was the average weight? (10) _____
- (11) If a map scale is $\frac{1}{8}$ in. = 50 miles, then $2\frac{1}{2}$ in. is equal to how many miles? (11) _____

- (12) Paul sells magazine subscriptions at \$4.00 each. He has to send the company \$3.00 of every subscription that he sells. What percent of the subscription money does he keep? (12) _____
- (13) Tom pays $1\frac{3}{4}$ ¢ for each newspaper. He sells them for 3¢ each. How much does he make if he sells 56 newspapers? (13) _____
- (14) Angle A of triangle ABC is 45° and Angle B is 55° . How many degrees are there in Angle C? (14) _____
- (15) A railway locomotive weighs about 15 tons. A motor car weighs about 3000 lb. The locomotive weighs about how many times as much as the motor car? (15) _____
- (16) The school nurse reported that 20% of the children in the first grade of the Edmonton Public Schools are underweight. If there are 2000 children in the first grade, how many are underweight? (16) _____
- (17) At a "1/5 off" sale, Betty's mother bought her two \$6.00 dresses. How much did she pay for the two dresses? (17) _____
- (18) If a cubic foot of granite weighs 150 pounds, how much would a block of granite 4 feet long, 2 feet wide and 3 feet deep weigh? (18) _____
- (19) A dealer buys bicycles listed at \$50. He receives a discount of 20%. What is the net price? (19) _____
- (20) Find the length of the circumference of a circle if its radius is 14 inches. (20) _____
- (21) A section of land was sold by an agent for \$25.00 per acre. If the agent's commission was \$1.00 per acre what amount did the owner receive from the sale of his land? (21) _____
- (22) The angles of a triangle are represented by $5X$ degrees, $6X$ degrees and $7X$ degrees. Find the number of degrees in the largest angle. (22) _____
- (23) A parcel to be sent by Parcel Post weighed 21 lb. 4 oz. The postal rate is 2 cents for the first, second, third, fourth, fifth and sixth ounces, and one cent an ounce for every ounce over the sixth ounce. What will it cost to send the parcel? (23) _____
- (24) An agent sold a 160-acre farm for \$50 an acre. What was his commission at $3\frac{1}{2}\%$? (24) _____
- (25) My store is valued at \$9000. It is assessed at $\frac{2}{3}$ of its value and the tax rate is 30 mills. What is my annual tax bill? (25) _____
- (26) The list price of a piano is \$600. The trade discounts are 15% and 10%. What is the net price? (26) _____

ANSWERS

B29765